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The Coal Strike and Water Power

DURING the past weeks the prospects of water-power development have measurably brightened. It has been borne in upon many who have held that steam power can be produced more cheaply than water power, even where the latter is available, that steam means coal and that coal is one of the many commodities which promise to show an increasing cost with the growing demands of labor. The first cost and the operation of the hydro-electric plant involve labor, and therefore are responsive to any increases that labor will get, but the fuel that feeds the water-wheels is not so affected. It looks as though the time is approaching when with far greater frequency than ever before the cost of transmitting the energy from the place where water power exists is going to be less than the cost of getting the coal to the place where the energy is needed.

Utilizing All the Head

WHEN the economic advantage noted in the last paragraph begins to assert itself, no small part of the hydro-electric development work undertaken will be in the way of improving existing plants. By the installation of more modern machinery and by the more efficient utilization of head, more energy can be delivered from the same amount of water. This is just what is being done at Niagara Falls in the Queenston development by the Hydro-electric Power Commission of Ontario, the progress of which is described on another page. Instead of the 12 hp. per second-foot of the early Niagara plants and the 20 of the latest American plant which uses only a part of the full head of the river, the new Canadian development will deliver 30 hp. per second-foot and utilize all but 25 ft. of the 330-ft. difference in the level of the two lakes. Of course, these figures do not mean anything in ultimate economy unless first costs are given, and until the Queenston work is completed these will not be known. Unit construction costs are rising almost daily, and estimates on such work as the long canal from Chippawa are apt to fall far below the final bill, but the principle there will undoubtedly have growing application. If it were not for the engineer's ability each year to approach more nearly the full utilization of the resources of nature, the prospects for the remote future would indeed be bad.

Progress in Sludge Dewatering Tests

DEWATERING sewage sludge to the satisfaction of the fertilizer trade is no easy task. It means reducing the moisture content of a hugh volume of sludge by some 90%. If this can be done it may revolutionize sewage treatment, or at least it may assure the success of the activated-sludge process, which produces a sludge of high nitrogent content. So much hinges upon this possibility, both as to sewage treatment in general and activation in particular, as to invest with unusual interest the large dewatering plant at Houston, Tex. (p. 1003). The changes in mechanical details that have been found necessary while this dewatering plant was still in the hands of the contractor, combined with the fact that operating charges and a fair allowance for depreciation have yet to be determined by service results, force the conclusion that sludge dewatering is still in an experimental stage. Perhaps it would be fairer to say that it is about to have its first full-sized working-duty test. It is particularly satisfying to note that the entire range of operations, financial as well as physical, at the Houston activated-sludge plants are being recorded, so that when the dewatering plant has been in use a year or two, clear and abundant light on its success from all viewpoints may be expected.

A Meaty and Readable Annual Report

FROM the keynote lines by Browning beginning, "The common problem, yours, mine, everyone's," to the summary of statistics according to the New England Water Works Association schedule, the latest annual report of the water commissioner of St. Louis is so interesting and useful that it might well serve as a model. After the report is read it is easy to see why Mr. Wall has been connected with the St. Louis water-works for so many years. Besides being an efficient public servant, he has the rare faculty of giving an interesting and instructive account of his stewardship.

Lessons from Filter-Plant Operation

OF SPECIAL interest and value is the information on filter-plant operation given in the St. Louis report. Here are described the everyday difficulties of the operator and how they were met—difficulties which must be overcome if a filter plant is to run with efficiency and economy. Troubles are analyzed, and all the loose points in operation, as well as in original design of equipment, are covered. Thus, to emphasize only a few of the points brought out in the abstract of the report printed on page 935 of our issue of Nov. 27-Dec. 4, 1919: The old idea that holes in a board for the bottom of a solution-dissolving box may be replaced with anything better is practically exploded. Strainer plates are not yet made simple enough to be foolproof in construction. Bronze orifices ought to be made in the form of bushings, and no one hereafter will use tile pipe for the passage of chlorine solution. Throughout the whole discussion, in giving reasons for and against certain practices —reasons based on experience—the designer is served in a measurable way. The same is true as regards hints

for operators. Doubtless similar lessons are being drawn from other filter plants, but too few of them are made available through such illuminating reports as are prepared by Mr. Wall and his able staff.

Drainage and Again Drainage

ELSEWHERE in these columns will be found comment upon the success achieved with penetration-bituminous roads in Rhode Island. Five reasons are there given why the work has been so successful. Mr. Patterson, questioned on the subject, has emphasized that drainage is the most important of these. Experienced roadbuilders will thoroughly agree with him. But Mr. Patterson's emphasis is not one of mere theory. His article testifies that he takes scrupulous care of the drainage, while the evidence afforded by the roads themselves gives the full and final proof. How often do we hear engineers protest that they give careful attention to drainage and subgrades, and then find that they have let contracts for a two or three or five-mile stretch in which there is no variation in foundation design! In theory they worship at the shrine of drainage; in practice they seem to regard it as a false god. In the section on drainage Mr. Patterson has written one of the best treatments in American technical literature on highway foundations and drainage. It may well form a text for and an inspiration to highway engineers everywhere, even though they are not convinced of the value of penetration-bituminous surfaces or have conditions that forbid the use of that type.

Let the Facts Speak

SUCH excellent work has been accomplished by the Joint Employment Bureau of the national engineering societies that the simple facts of the work as reported at the recent annual meeting of the American Society of Mechanical Engineers by Secretary C. W. Rice are enough to give the bureau a brilliant record. No comparison with the work of other organizations was needed to make the record more distinguished. Regard for proper comity between engineering societies might well have kept Mr. Rice from contrasting the efficiency of the bureau which he conducted with that of another society's employment service. He thought fit to present such a contrast, however. This would not call for comment here except for the fact that the figures he quoted were grossly and unexplainably in error, to the disadvantage of the other organization. Said Mr. Rice:

"In a recent publication of the American Association of Engineers they stated that during the last three months they had been notified of 1000 positions which were vacant, that they had recommended to these positions about 3000, and had placed in positions 271. So that you may know that we are not failing to do our duty, I will report that we have received about the same number, namely, 1000 notices of vacancies to be filled; we have nominated 6000 men for these places, and have placed 374. The expense of the American Association of Engineers in their activities, which, according to their own statement, is primarily if not exclusively that of welfare work and of getting positions, was, according to their published statements, upward of $40,000 during the last three months. They have placed, with an expenditure of $40,000, 271 men in positions. Your Joint Bureau was maintained at an expense of $3750 during the last there months, and has placed 371 men in positions. In other words, it took $40,000 by the American Association of Engineers to canvass and place 271, and it took $3750 under our auspices to canvass and place 374 men."

Long before this, the association had publishedd the fact that its employment work cost $1 per member per year, which on the basis of 8000 members means about $2000 for three months. On inquiry we learn that the exact figure is $1900. If Mr. Rice did not have these figures he could easily have obtained them; but he was content to make a haphazard statement that is gravely unfair to a sister society. He succeeded in being just 1900 per cent. away from the truth. Possibly the absurd error did not deceive the engineers who heard him, for they know that two similar services are not likely to show relative costs of 10 and 1. Nevertheless, harm was done, we believe, by placing the untrue comparison before a formal public session of technical men assembled from all over the country, and the harm should be made good by equally wide circulation of the facts. Surely, such irresponsible citation of inter-society "statistics" does not promote the spirit of coöperative service to the world that today pervades the engineering societies. We repeat, therefore, that it is regrettable that the statement on the Joint Bureau was not confined to the simple facts. The bureau's achievements are able to speak for themselves, and have no need for tricks of publicity. Good wine needs no bush.

Penetration Surfaces on Heavily Traveled Roads

IN MANY sections there is an opinion that for trunk highways there are only two types of bituminous road that will give satisfactory service—sheet-asphalt and mixed-bituminous surfaces, both laid on a concrete base. In this issue is an article by I. W. Patterson which refutes that view. We say this not merely on account of the evidence in the article itself, but from a personal inspection of the roads.

The bituminous road has suffered not merely from the fact that it did the first pioneering in the fight against destruction by automobile tires, but because the higher forms resemble in surface appearance the cheaper types.

Ten years ago, when we were in panic because, with the advent of the automobile, tires began to suck the binder out of our waterbound macadam and gravel roads, flinging the metal into the gutters, bituminous materials were the first to step into the breach. Everybody experimented. There were failures—failures that were to be expected. These were sometimes in the higher types of surfacing, but the greater number were in surface-treated roads.

The failures of those days became, in many minds, generalizations. A bituminous road was a bituminous road, whether it was a surface-treated macadam or a high-grade penetration or mixed job. Such was not the case with other types. Concrete, brick, granite block are distinct types. They will not be condemned if a surface-treated macadam or gravel breaks down under traffic or rolls up a $700 annual surface-maintenance charge. But sheet asphalt on a concrete base, because it looks like the cheaper road, is included by the unthinking in a general, and unwarranted, condemnation.

What stands out clearly in the work done in Rhode Island (and in Massachusetts also) is that penetration roads on heavy rock and gravel foundations have stood up under trunk-line traffic. There may have been failures elsewhere, but any number of failures cannot negative the fact that on main routes in Rhode Island and Massachusetts penetration roads without concrete bases have given satisfactory service. It is true that this traffic is not as heavy as that which follows the main routes around such cities as Cleveland and Detroit, but the traffic is reasonably heavy. The data in this issue deserve a careful study by highway engineers. Fully digested—studied as an engineer should study them—they should cause a revision of many quite widely held views.

Naturally, the first query will be as to the details of construction. Why have the roads been so successful? The question is answered in Mr. Patterson's article. Briefly, he accounts for the success under five heads: (1) Very thorough drainage; (2) the use of hard stone; (3) the use of stone of large size in the penetration top; (4) the use of asphalt of low penetration; (5) very thorough rolling, before, during and after the penetration process.

Each of these is an important factor in the success of the finished surface, and no one of them can be neglected without endangering the results. In other words, it requires quite as much, if not more, attention to detail to get a successful penetration top as it does to lay a concrete pavement. Mr. Patterson's article bears out again what we all really know but must emphasize constantly—that successful highway work requires scrupulous attention to detail. This scrupulous attention carries its own reward, as is evidenced by the excellent results which Rhode Island has achieved.

Revolutionary Changes in the Steam Locomotive

FOR half a century there has been no fundamental development in steam-locomotive design. Except as to size and tractive power and the addition of the superheater to the steam generating unit the elements of the moving power plant have remained relatively unchanged. Progress up to the present time has been gradual and has never involved sudden changes in operating limits and general arrangement. Now it is proposed to develop a locomotive that will at once involve such radical departure from present practice as suddenly to revolutionize the whole design.

It is generally agreed that we are approaching, if we have not already reached, limits of clearance and weight. The need for greater efficiency in railroad operation and in the conservation of fuel have become so apparent that we must look to essential, if not radical, changes in the elements of design, if much greater progress is to be made. The able presentation of the subject by John E. Muhlfeld, formerly general superintendent of motive power of the Baltimore and Ohio R. R., before the annual meeting of the American Society of Mechanical Engineers in New York City, Dec. 5, in his paper, "The Scientific Development of the Steam Locomotive," is notable because it embodies proposals for such definite changes in practice as may bring about a revolution in the art of locomotive design. With the increase in boiler pressure and degree of superheat, the reduction of reciprocating effects and the general refinement of mechanism that Mr. Muhlfeld proposes, it is reasonable to assume that the outcome will be—in operating results and in appearance—an almost entirely new machine.

Briefly, it is proposed to raise the boiler pressure from the present standard of 200 lb. per square inch to 350 lb., in combination with 300° F. of superheat, giving a cylinder temperature approaching 750° F., the maximum considered practicable in the present development of valve practice and lubrication. Cylinders would be compounded and back pressure reduced to utilize the greatly increased temperature range. Present outside valve gears would be replaced with a different arrangement to insure a better maintained steam distribution. Reciprocating parts would be lightened and the distance between cylinders considerably reduced to cut down nosing effects to a point permitting the elimination of guiding trucks and affording greater weight for traction. The factor of adhesion would be somewhat decreased, presupposing a better sustained flow of power delivered at the rail. Combustion would be so regulated as to permit the use of low-grade as well as high-grade fuels. An almost complete change in boiler design, involving the use of an economizer for preheating feed water, would take place. With respect to the locomotive as a whole, there would be a degree of mechanical refinement more like that obtaining in marine and stationary engines.

There is, then, under consideration a machine that represents a revolution in locomotive practice; one that will develop a considerably greater thermal efficiency and somewhat greater tractive effort—certainly a much greater tractive effort at the higher speeds. In consideration of European results in the use of high pressure and superheat in steam engines of the "Unaflow" type (which have developed "absolute" thermal efficiencies of more than 15%—comparable to the Diesel engine), proposals for high-temperature range in locomotive practice should not be lightly dismissed. Evidently, an entirely different valve and cylinder arrangement, with corresponding changes in power transmission, is contemplated. In light of the emphasis laid upon mechanical refinement, it is likely that there will be needed a frame and journal box arrangement similar to European practice, to replace the existing American practice of providing a system of equalizers to compensate for track irregularities.

So far, greater emphasis is placed upon the development of higher thermal or fuel efficiency than upon a material increase in tractive power—and, therefore, a material increase in weight—to bring about operation in still larger units without exceeding present clearances. But when an increase of 75% in boiler pressure is so forcefully proposed, the likelihood of considerably increased wheel loads, as a result of a heavier boiler, will immediately suggest problems to the civil engineer that may, at first, appear impracticable of solution. It is likely that the expense involved in a general increase of clearances, necessary for much larger cylinder dimensions, with present principles of design, would considerably exceed the expense of providing for the greater weight of a locomotive within present clearance limits but with a heavier boiler and greater tractive effort. Certainly, should it appear that the saving in general operating expenses could be capitalized to provide for materially increased wheel loads, civil engineers will be called upon for solution of the problem.

Why Bituminous Macadam Is Successful in Rhode Island

Painstaking Attention Paid to Design of Foundation and Drainage Facilities—Materials Carefully Selected—Cost Reasonable—Traffic Heavy

By Irving W. Patterson
Chief Engineer, State Board of Public Roads, Rhode Island

GREAT CARE IS EXERCISED IN LAYING STONE FOUNDATION

THE first instance of the use of bituminous macadam built by the penetration method upon the state highway system of Rhode Island was in 1913. During the period between 1906 and 1912 inclusive a rather extensive use of bitumens was made, but during this earlier period the use of bitumens was confined almost without exception to the cold-mixing method. The aggregate employed for the cold-mixing work was crusher-run stone from ½ in. to 1½ in. in size. This type of construction according to present definition should be termed bituminous concrete, although the character of the aggregate would seem to warrant its designation as bituminous macadam by the cold-mixing method. The roads built by the cold-mixing method were described in many publications a number of years ago by Arthur H. Blanchard, and for this reason and also because of the fact that this type of construction no longer is employed in Rhode Island, the writer will confine his remarks to penetration work.

In 1913 the conditions surrounding the state road situation in Rhode Island were rather discouraging because of the fact that funds for reconstruction and maintenance had been so meagre that little had been accomplished toward rebuilding or resurfacing the wornout waterbound macadam roads built in the period from 1896 to that time. The funds available in 1913 also were so limited that it was deemed out of the question to lay pavements of the so-called durable type. The engineering force, which had recently undergone considerable change in personnel, was called upon therefore to select types of construction which were relatively inexpensive. An examination into the results secured in Rhode Island in previous years by the use of the cold-mixing method disclosed the fact that the results were erratic. Some of the roads built by this method were in almost perfect condition and had required little maintenance, while other roads built under the same specification had given very poor service. It appeared that very slight variations in the quality of crushed stone employed in this type of construction were responsible for widely varying results secured.

This examination brought to light the surprising paradox that the best quality of stone according to usual standards gave the poorest results. The fact that a soft stone broke up under the roller sufficiently to bring about a more perfect grading of sizes than was involved in screening very likely accounted for this peculiarity. Although good results were secured by the use of soft stone in our cold-mixing work, we have found that only a hard, tough stone gives good results in our penetration work. A continuation of the use of the cold-mixing method was not deemed advisable. An investigation into the penetration method led us to believe that very good results could be secured by that method in certain localities. It appeared that bituminous macadam had failed in many sections by reason of foundation defects, by reason of waving or corrugation of the surface and by reason of ravelling of the wearing surface. An attempt was made therefore to adopt a practice in regard to the design of foundations and drainage facilities, in regard to selection of materials and in regard to construction details, which would

remedy to some extent these defects. The specification first employed for the work done in 1913 has been modified somewhat in minor detail but no radical changes have deem deemed necessary. The results secured upon our penetration roads have exceeded our expectations somewhat. Resealing of none of our penetration roads has as yet been necessary and the repairs have been comparatively inexpensive.

Our construction has not been confined to bituminous macadam. For several years past we have selected frequently other types of construction such as bituminous concrete both upon a macadam base and upon a concrete base and cement concrete. We still believe, however, that there is a field in Rhode Island for bituminous macadam upon our main trunk lines.

In our early investigation into bituminous macadam by the penetration method it appeared to us that waving or corrugation of the wearing surface of penetration roads was due to five causes, viz.: the use of asphalt of too high penetration, the use of excessive amounts of binder, the use of crushed stone of too small sizes in the wearing course, the use of soft stone in the wearing surface and inferior construction methods. Waving of the surface of penetration roads is one of the most serious defects of this type of construction as frequently built and is, if it develops, very nearly irrevocable. Attributing the cause of waving to the conditions mentioned previously, we adopted the use of an asphalt of comparatively low penetration, we employed a hard crushed stone screened to large sizes for the wearing surface and we exercised care in the construction.

Detailed Construction Data Are Furnished Each Inspector

RHODE ISLAND STATE BOARD OF PUBLIC ROADS

Contract No. 1903 1919 Reconstruction

Town of Smithfield-Gloucester (Putnam Pike)

Information for Inspector—Special

Made by G.H.H. Chk'd by F.H.W.

Date. 3-31-19 Date 3-31-19

Traffic: The road will be kept open to traffic at the driver's own risk until crushed stone is spread; after which the road will be closed to traffic. The contractor will place all necessary signs where needed before construction begins.

Stationing: Sec. I. extends from Station 3950 to 5280
" II. extends from Station 0 to 5280
" III. extends from Station 0 to 5280
" IV. extends from Station 0 to 850

Center Line: From Sta. 3950 to 4350 Sec. I., the center line is to be 10½ feet from the rail.
From Sta. 4350 Sec. I. to Sta. 250 Sec. II., the center line is to be located from the grade stakes.
From Sta. 250 Sec. II. to 850 Sec. IV. the center line is to be 10½ feet from the rail.

Grade: The grade marked upon the grade stakes is the finished grade for the center line.

Transverse Slopes: In general the surface of the metal is to slope from the center to the sides at the rate of ½ inch per foot.

Banked Curves: The surface of the metal on banked curves slopes as follows:

Sec. III. Sta. 400 left down ½ inch per ft. for 9 ft.; Right level for 9 ft.
450–650 left down ½ inch per ft. for 9 ft.; Right up ½ inch per ft. for 9 ft.
700 left down ½ inch per ft. for 9 ft.; Right level for 9 ft.
Sec. IV. Sta. 450 left down ½ inch per ft. for 9 ft.; Right level for 9 ft.
500 left down ½ inch per ft. for 9 ft.; Right up ½ inch per ft. for 9.5 ft.
550 left down ½ inch per ft. for 9 ft.; Right up ½ inch per ft. for 11.5 ft.
600 left down ½ inch per ft. for 9 ft.; Right up ½ inch per ft. for 13.0 ft.
650 left down ½ inch per ft. for 9 ft.; Right up ½ inch per ft. for 14.0 ft.
700 left down ½ inch per ft. for 9 ft.; Right up ½ inch per ft. for 13.5 ft.
750 left down ½ inch per ft. for 9 ft. Right up ½ inch per ft. for 11.0 ft.
800 left down ½ inch per ft. for 9 ft.; Right level for 9 ft.

Width: The surface of the new metal is to be 18 ft. wide except on the banked curve (Sec. IV), where it is to be approximately as noted above.

Note: The inspector is to measure and report all varying widths by stations in order that the office can compute the area of new metalled surface. Also all varying shoulders and side ditches from the sample section, and the exact stations where side ditches begin and end. This is necessary in order that the office can compute the actual excavation to be paid for.

Shoulders and Side Ditches or Gutters: See Sample Sections.

Side ditches or gutters formed as per sample sections are to be constructed where practicable, the entire length of the contract.

The inspector will measure and report the exact dimensions of the gutter or ditch employed by stations—giving the distance out from the center line and depth below finished grade.

Note: Sec. II. Right side, ditch from Sta. 4800 back to the culvert at Sta. 4700 approx.
Sec. IV. Right side, grade ditch to meet culvert at Sta. 190 approx.

Grading: The depths to excavate for metal and foundations are shown on Grading Diagram. All variance from same should be reported. In any case strip all loam within 24 inches of finished grade.

Culverts:

Sec. I. Sta. 4159–4120 approx. Replace present culvert with 72 ft. 18 in. corrugated metal pipe.
4775 approx. Place new standard concrete box culvert 3 ft. high x 2 ft. wide at low point under new fill (see sketch). Estimated length 100 ft.
5245 approx. New culvert to drain from right to left. 56 ft. of 12 in. corrugated metal pipe.

Sec. II. Sta. 1625 approx. Rhode Island Co. reports a 24-in. cast iron pipe in this location. Investigate and extend if necessary (consult engineer).
2065 As above (consult engineer).
3287–3318 approx. culvert. Replace with a standard reinforced concrete box culvert 5 ft. high x 5 ft. wide at Sta. 3325 approx. right to Station 3315 approx. left (see sketch). Use present culvert until new is built, then tear down and fill in. Esti. length new culvert 40 ft.
4700 approx. culvert. Replace with 44-ft. 18-in. corrugated metal pipe.
Drop flow line to get 12-in. approx. fill between top of pipe and track ties.
Ditch from outlet on left.
Trench on right from 4800 approx. to meet flow line of culvert.

Sec. III. Sta. 880 approx. culvert. Replace with standard reinforced concrete box culvert, 3 ft. high x 4 ft. wide. Est. length 40 ft.
1467–1512 approx. longitudinal culvert. Replace with 50 ft. 18-in. corrugated metal pipe.
1997 approx. Catch basin and culvert. Build catch basin (26-in. ring and cover) 28 ft. from rail, taking flow from old stone box culvert. Lay 60 ft. 12-in. cast iron pipe from new catch basin out under the tracks in a line just east of the shed at Sta. 1945 approx.
2320 approx. Catch basin and culvert. Build catch basin with curb inlet at 2300 approx. right. Lay 110 ft. approx. of 18-in. corrugated metal pipe from catch basin under side walk along the north side of road to N. Scituate to present drop inlet.
2475–2410 approx. culvert. Replace present culvert across the road as far as the building on the left with a standard concrete box culvert of equal capacity as the present culvert at its left end where it enters the building. Estimated dimensions are 2 ft. x 3 ft. x 58 ft.
2500 approx. Build curb opening drop inlet on right with 24 ft. of 18-in. corrugated metal pipe leading out of same under sidewalk into the lot near the new concrete culvert. The above is to intercept the water coming down the hill and throw same into lot on right where it will flow through large culvert.
3875 approx. culvert. Replace with 44 ft. 18-in. corrugated metal pipe.
5020 approx. culvert. Replace with 42 ft. 18-in. corrugated metal pipe.

Sec. IV. Sta. 14–33 approx. longitudinal culvert. Replace with 18 ft. 18-in. corrugated metal pipe.
190 approx. culvert. Replace with two 44 ft. lengths of 12-in. corrugated pipe.
560–630 approx. longitudinal culvert. Replace with 72 ft. 18-in. corrugated pipe.
740 approx. culvert. Extend present concrete arch culvert under the track across under the road. Estimated length 33 ft.

Cobble Gutter with Header:

Sec. II. Sta. 3450 to 3950 approx. Standard Section 5 ft. gutter with header (See sketch).

Sec. III. Sta. 275 to 725 approx. Standard Section 5 ft. gutter with header (see sketch).
1150 to 1450 approx. Standard Section 5 ft. gutter header (see sketch).
NOTE: Meet outlets to the culverts at 1150 approx.
2500 to 3150 approx. Standard Section 5 ft. gutter with header (see sketch).
NOTE: Construct header at Sta. 2500 to throw water into new curb opening.

Rip-Rap:

Sec. II. Sta. 1200 to 1400 approx. on left.
Report widths by stations in order that office can figure square yardage.

Guard Rails: Locations to be determined during construction.

The depth of crushed stone composing the wearing surface is made as nearly uniform as is possible. In resurfacing of old macadams especially it frequently happens that the depth of crushed stone constituting the wearing surface varies considerably because of the very common practice of laying the crushed stone in one course only over an irregular base. In all of our penetration work we make a practice of laying the crushed stone in two courses so that the top course or wearing course may be made very uniform in depth.

The sizes of crushed stone employed in both the base course and in the wearing course are the same, being of sizes passing a 2½ in. screen and retained upon a 1½ in. screen. The depth of the wearing surface is made 2½ in. thick after compression.

The bottom course of crushed stone always is filled with sand or with crusher-run screenings. The depth of the base course does not vary greatly over various types of foundations and sub-soils. We very seldom increase the depth of the base course of crushed stone in order to strengthen the pavement where sub-soil conditions appear to make a stronger construction desirable. It has been our experience that crushed stone does not make a satisfactory foundation over unstable sub-soil. Some type of foundation other than crushed stone therefore always is employed where the sub-soil conditions are unfavorable.

As a rule the base course is made 3½ in. thick after compression so that the total depth of the pavement is 6 in. Over heavy rock foundations, however, we make a practice of laying the base course of crushed stone 2½ in. thick. We are not in favor of laying the crushed stone in one course even over heavy rock foundations. In order to secure a smooth uniform surface it is very essential to have the crushed stone constituting the wearing surface free from irregularities which would be objectionable in the finished surface previous to the application of the bitumen. We have discovered no method of repairing irregularities due to faulty spreading of the crushed stone constituting the wearing surface after the bitumen has been applied.

Rolled to Get Maximum Mechanical Bond

Previous to the application of the bitumen the crushed stone constituting the wearing surface is thoroughly rolled. We make a practice of rolling until there is no sinking or creeping ahead of the roller and until a loaded cart or truck leaves no appreciable mark. It frequently is claimed that over-rolling of the stone constituting the wearing course is a condition prejudicial to the securing of good results. The theory which we work upon is to secure the maximum mechanical bond which is possible and to augment this bond with the bitumen. One of the reasons frequently given for not rolling the wearing course of stone heavily is that the individual pieces of stone fracture to such an extent that proper penetration of the bitumen is not secured. The writer is of the opinion that no crushed stone should be used for the wearing course in penetration work which is soft enough to break up seriously under rolling as heavy as is described.

Our best results have been secured with trap rock (basalt). Our observation leads us to believe that the ability to secure trap rock for the wearing surface or the ability to secure a stone approximately as good should be a condition precedent to the selection of bituminous macadam. Although a hard granite, a good quality of quartzite, a hard indurated sand stone and a number of other types of rock usually considered rather inferior may give very satisfactory service for a few years, our experience indicates that the use of anything but the best quality of crushed stone for the wearing surface involves high maintenance costs unless very light traffic is to be provided for. It is a fact, however, that the initial "surfacing-up" process is much more rapid where a rather soft stone is employed. We have noted that as a rule a penetration road built of fairly soft stone presents a tighter surface for approximately two years after its construction than does a road built of trap rock. In the selection of stone to be employed for the wearing surface it is also essential to avoid rock which is characterized by adhesion of fine rock powder to the large sizes of crushed stone. Some of the quartzites have this peculiarity in marked degree.

The greater part of our bituminous macadam work has been constructed of asphalt of penetration between 90° to 100°. There has been a general tendency within the last few years toward the use of harder asphalt for penetration work, but when our first penetration work was done in 1913 the use of an asphalt of such low penetration was unusual. We have secured excellent results from the use of an asphalt of penetration of approximately 55°. We never have employed an asphalt of penetration higher than 130°. At present our specifications invariably call for an asphalt of penetration between 90° and 100°.

The first or binding application of asphalt is made at the rate of 1¾ gal. per square yard of surface, volume measured at air temperature. We have employed both the hand pouring method and machine distribution. Our results indicate that hand pouring is fully as efficient as machine distribution, but we do not feel justified in stating that results secured by the hand pouring method are superior to the results secured by machine distribution.

Immediately after the application of binder the key stone or the crushed stone employed to fill the surface voids in the wearing course is spread. As the key stone is spread, so does the finished surface appear. We attempt only to fill the surface voids but we are careful to see that practically all of the surface voids are filled. Workmen may become so proficient at spreading the key stone that little sweeping is necessary, but ordinarily sweeping of the key stone into the voids is required. We employ for the key stone crushed stone of sizes passing a 1 in. screen and retained upon a ½ in. screen. We urge the necessity for having this stone free from stone dust. After the key stone has been spread satisfactorily the surface is well rolled. It usually is necessary to touch up spots which show a deficiency of key stone during the rolling operation.

Conditions Governing Seal-Coat Application

Conditions affecting accumulation of dust upon the surface of the road influence the length of time intervening between the spreading of the binder application of asphalt and of the spreading of the second application of asphalt, or the seal-coat. In general we do not favor applying the seal-coat upon the same day that the first application is spread. If, however, there is a car track in the highway or if traffic is carried upon a portion of the highway, there is a possibility that dust will be blown upon the surface to such an extent that the application of the seal-coat should be made as soon

as possible. Care of course always is taken to avoid applying asphalt upon wet stone.

We apply the seal-coat at the rate of between ¾ gal. and one gal. per square yard of surface. The fact that the key stone is fairly large in size permits the use of a heavier seal-coat than would be possible if a smaller stone were employed. The use of key stone of comparatively large sizes does not permit the seal-coat to lay upon the surface in blanket form. Puddling of the seal-coat is very rare in our work in spite of the fact that the amount employed for it is more liberal than is customary.

Immediately after the application of the seal-coat a cover of crushed stone of sizes passing a ⅝ in. screen and retained upon a ⅜ in. screen is applied. The cover is applied in amount only sufficient to cover the surface. Care is essential to avoid bunches in the material employed as a cover, because while the road is plastic irregularities in the finished surface may result from these bunches during final rolling. We consider it a disadvantage to have the cover applied in amount materially greater than will bond to the seal-coat. For work finished late in the season we consider a large excess of covering material very detrimental in view of the fact that the "surfacing-up" process is retarded and the pavement is called upon to go through the winter covered by a layer of mud produced by the grinding up under traffic of the covering material. A penetration road which does not have an opportunity to complete its initial "surfacing-up" process before winter sets in is, in the opinion of the writer, greatly handicapped. Anything which retards the surfacing process should be avoided, and anything which will hasten it is desirable.

Rolling Completed Surface

Rolling of the pavement after it is completed is a matter which appears to be slighted frequently. The rolling of a penetration road is a vastly different proposition from the rolling of sheet asphalt or of bituminous concrete having a well graded mineral aggregate. The extent of rolling means little, however, unless care is used to roll at the right time. It is desirable to have the temperature high enough so that the road is somewhat plastic in order to secure the best results in final or back rolling. We endeavor to have the rolling of the finished pavement carried out for a period of two weeks. The time of rolling of course is dependent upon the season of the year during which the work is done. Rolling of the finished pavement should be avoided when it is raining or when the pavement is wet from previous rains. In the fall rolling of the finished surface is not efficacious when done in the early morning or late afternoon. When the weather becomes cold it is essential to do the back rolling at the time of day that the temperature is the highest. The "surfacing-up" process is greatly hastened by heavy rolling after the pavement is completed. We deem it also desirable to roll the finished pavement after traffic is allowed upon the road. The combination of vehicular traffic and rolling seems to be more effective than mere rolling without traffic. It is of course possible to roll too much at one time. During very warm weather especially the effect of rolling must be observed carefully in order that too much rolling may be avoided. During the summer months the final rolling frequently is more effective when done in the early morning or late afternoon. Although the writer was of the opinion that extensive rolling after the completion of the pavement is policy, he did not appreciate the value of this feature until he had an opportunity to observe the effect of very heavy rolling upon a section of newly finished road caused by the hauling of a large quantity of crushed stone over the road by means of a steam roller employed as a tractor. The hauling of the crushed stone over the section of newly finished road referred to was occasioned by extension of a contract upon the end farther from the source of supply of stone. The crushed stone was hauled over the newly completed section, much against the desires of those in charge of the work, immediately after the road was open to traffic. The section of road involved in the extension of the contract never presented such a perfect surface as did the section over which the hauling by means of the steam roller was carried out. The section done last, however, was finished about midsummer so that the difference in the surfaces of the two sections well could not be attributed to the fact that the section done later was finished late in the season. The difference in the surfaces of the two sections is not microscopic in any sense of the word, but is evident even to the casual observer. We feel that the matter of rolling penetration roads has not received generally the attention that it deserves.

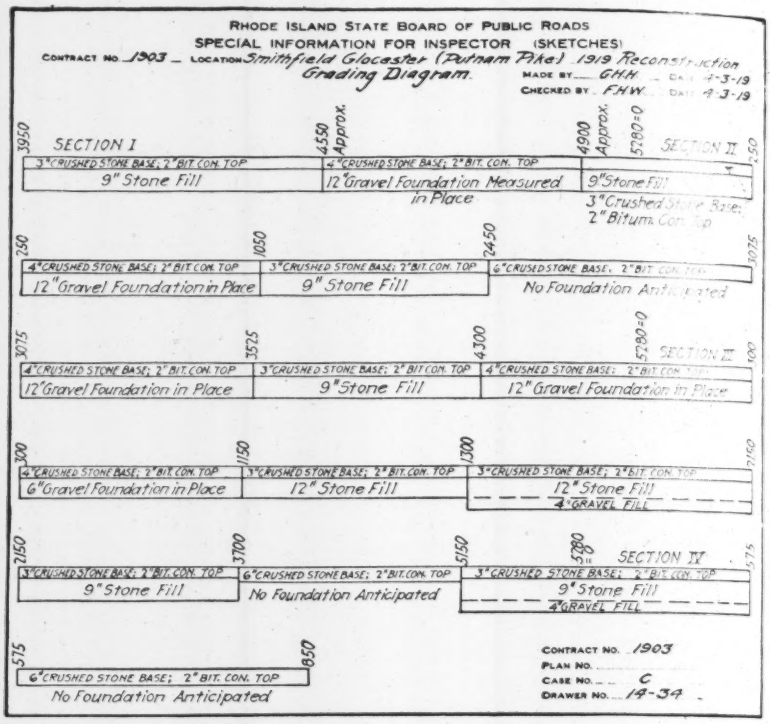
Foundations—Drainage

The design of foundations and of drainage facilities is of course of the utmost importance, regardless of the type of surface construction involved. The most careful attention to technical and practical details in the surface construction of a penetration road are of no avail unless adequate foundations and adequate drainage facilities are provided.

The sub-soil conditions in Rhode Island are extremely varied in spite of the fact that our state is so small. There are certain well defined areas, as for instance the Island of Rhode Island, where the sub-soil is uniformly heavy and clayey and subject to a great deal of heaving during thaws. There are also well defined areas where the sub-soil encountered is uniformly coarse, sandy gravel affording admirable sub-drainage. There are also sections where alternate streaks of heavy impermeable soil and of sandy or gravelly soil occur at fairly short intervals. The greatest attention is given to design of foundations. *The planning of steps to be taken to meet adverse sub-soil conditions is done only by engineers connected with the main office and nothing is left to be decided upon by those supervising the construction.* The greater part of our penetration work to date has been employed to replace wornout water-bound macadam. The problem of designing foundations is a great deal easier where a macadam road has existed for a number of years, because the inadequacies of foundations are very apparent in macadam surfaces. We believe that sub-soil conditions which cause a macadam road to rut or heave warrant the placing of foundations under a penetration road. The fact that the penetration surface ultimately is very nearly waterproof and has a tendency therefore to keep the sub-soil dry should not, we believe, be considered as a condition favorable to the omission of foundations, because certain sub-soils have such a marked capillarity that the waterproofing of the surface is of little avail. The problem of planning foundations for a road built in a new location or even upon the site of a dirt road,

especially where radical changes in grade are planned, is much more difficult than is the planning of foundations for a road surface replacing a macadam. In general, however, the proposition is very similar.

Observation of conditions existing during thaws in the winter we consider of the utmost importance in designing foundations, because it is at that time that the hydroscopic properties of the subsoil are very apparent. *The engineers responsible for the planning of foundations therefore make very careful inspection of conditions existing during a winter thaw.* The plans are taken along and rather copious notes describing the conditions then existing are made. In this preliminary inspection of conditions affecting the design of foundations the notes merely describe the conditions existing. The notes go into detail and the various conditions found are very carefully described and reference given to station numbers upon the plan so that the same points may be picked up later.


RHODE ISLAND STATE BOARD OF PUBLIC ROADS
SPECIAL INFORMATION FOR INSPECTOR (SKETCHES)
CONTRACT NO. 1903 LOCATION Smithfield Glocaster (Putnam Pike) 1919 Reconstruction
Grading Diagram.
MADE BY GHH DATE 4-3-19
CHECKED BY FHW DATE 4-3-19
SECTION I
SECTION II
SECTION III
SECTION IV
3" CRUSHED STONE BASE; 2" BIT. CON. TOP
9" Stone Fill
4" CRUSHED STONE BASE; 2" BIT. CON. TOP
12" Gravel Foundation Measured in Place
9" Stone Fill
3" Crushed Stone Base; 2" Bitum. Con. Top
4" CRUSHED STONE BASE; 2" BIT. CON. TOP
12" Gravel Foundation in Place
3" CRUSHED STONE BASE; 2" BIT. CON. TOP
9" Stone Fill
6" CRUSHED STONE BASE; 2" BIT. CON. TOP
No Foundation Anticipated
4" CRUSHED STONE BASE; 2" BIT. CON. TOP
12" Gravel Foundation in Place
3" CRUSHED STONE BASE; 2" BIT. CON. TOP
9" Stone Fill
4" CRUSHED STONE BASE; 2" BIT. CON. TOP
12" Gravel Foundation in Place
4" CRUSHED STONE BASE; 2" BIT. CON. TOP
6" Gravel Foundation in Place
3" CRUSHED STONE BASE; 2" BIT. CON. TOP
12" Stone Fill
3" CRUSHED STONE BASE; 2" BIT. CON. TOP
12" Stone Fill
4" GRAVEL FILL
3" CRUSHED STONE BASE; 2" BIT. CON. TOP
9" Stone Fill
6" CRUSHED STONE BASE; 2" BIT. CON. TOP
No Foundation Anticipated
3" CRUSHED STONE BASE; 2" BIT. CON. TOP
9" Stone Fill
4" GRAVEL FILL
6" CRUSHED STONE BASE; 2" BIT. CON. TOP
No Foundation Anticipated
CONTRACT NO. 1903
PLAN NO.
CASE NO. C
DRAWER NO. 14-34

GRADING DIAGRAM SHOWS FOUNDATION TYPE FOR EVERY FOOT OF ROAD

A subsequent examination is made in the early spring when the sub-soil is well saturated with water and when the frost is completely out of the ground. The idea of the second inspection of conditions is to determine the steps necessary to take care of sub-soil drainage. Springs always are in evidence in the early spring, but during the winter and during the summer they frequently are not in evidence. At the time of the second inspection foundations and drainage facilities are designed in detail. We have made a very careful survey of the location of materials suitable for foundations and the engineers making the design of foundations usually take with them notes concerning the availability of these materials in the section that they are working.

The types of foundations which we employ under penetration roads are heavy rock foundations, or stone fill, and gravel foundations. We never employ telford foundations, and we never employ crushed stone as a foundation proper. A telford is much more expensive to lay than is a stone fill, and over certain types of sub-soil the fact that there is direct drainage from the top to the bottom of the telford makes possible the working up of the sub-soil beneath when it is softened during thaws. The features influencing the selection of gravel and of stone fill, respectively, are the relative costs and the particular conditions to be met. A combination of both stone fill and gravel frequently is employed. Over clay, which is usually very unstable in this section, we prefer a gravel foundation to a stone fill foundation. We consider that the sand in the gravel is the active agent in overcoming the defects of the clay. We have secured perfect results by the use of fine sand over clay, but since sand is rather difficult to bind and causes therefore more or less difficulty in rolling, we prefer a gravel containing at least 40% by weight of stones retained upon a one in. screen. Since permeability is to be desired in gravel employed as a foundation, we specify that not over 25% of the particles passing a ½ in. screen shall pass a 40-mesh screen.

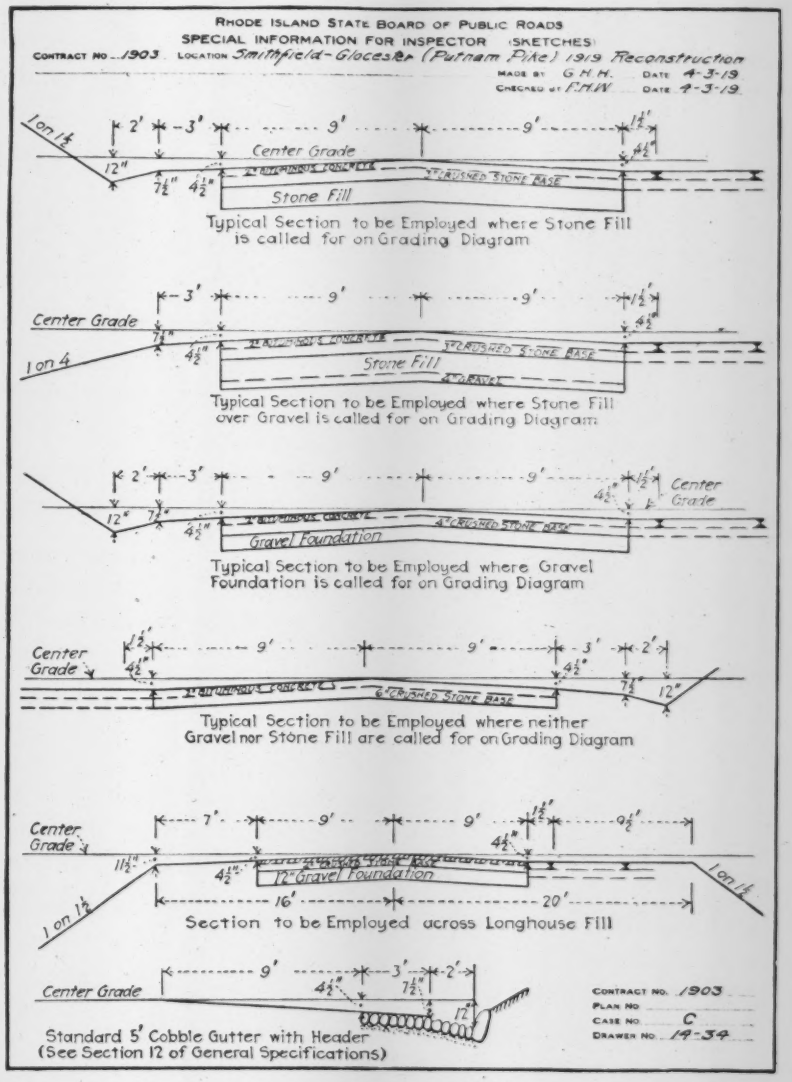
Stone fill is preferred where it is possible that more or less water will be present in the foundation. Over extremely unstable sub-soil a layer of gravel is placed below the stone fill in order to prevent the unstable sub-soil from working up into the stone fill and preventing thereby the seepage of water through the foundation. Gravel always is employed to fill the voids in the stone foundation. The stone foundation is brought to grade and the gravel is then spread over the surface. The gravel aids materially in consolidating the foundation and does not prevent the seepage through the foundation of small amounts of water. We do not believe in allowing large amounts of water in the rock foundation if it can be avoided. When there are decided springs, sub-drains at the side are provided to intercept the water before it reaches the foundation.

Stone fill always is employed where there is ledge. In New England much trouble is experienced by the breaking up of roads built upon ledge. Our ledges are very apt to be springy. In blasting ledge it is of course impossible to meet exact lines, and it is therefore fairly common to find undrained pockets in ledge which may become filled with water. The leaving of undrained pockets in ledge is to be avoided if possible, although it is not to be expected that a smooth contour in ledge excavation will be secured. Care in avoiding undrained pockets and a stone foundation we find very effective in ledge.

An improperly laid or improperly compacted stone foundation is very apt to result in an irregular wearing surface because of local settlement under traffic. We consider it a good plan to do all of the hauling over the stone foundations that is possible before any crushed stone is put on. The use of gravel to fill the

voids in the rock foundation makes it possible to haul over the foundation very readily.

Our stone foundations are constructed ordinarily of field, wall or ledge stone of sizes varying from 3 in. to 15 in. in longest dimension. The largest sizes permissible depend upon the depth of the foundation. We do not approve of the use of stones large enough to reach from top to bottom of the foundation unless the foundations are very shallow. The stones are all packed by hand, the loads being dumped so that there is a small clearance between the laid foundation and the piles dumped. There is a knack in laying the stone so that the surface will roll uniformly. If there are areas where the stone is loosely packed and other areas where the stone is compactly laid, the differences in laying are apparent after rolling because of the greater compression resulting where the stone is loosely packed. In general the sizes of stones used are graded from the largest sizes upon the bottom to the smallest sizes upon the top. It is important to have larger stones laid in such a manner that they do not tilt or rock under the roller. Considerable breaking of stones upon the surface with hammers during the rolling process generally is necessary. It is desirable to secure a fair percentage of broken stones in the foundation because of the difficulty experienced in rolling a foundation constructed wholly of round cobbles. It is difficult to predict the percentage of compression secured by rolling because there is a great variation in this feature produced by variations in the grading of sizes of stones, character of the rock employed and details of laying.


RHODE ISLAND STATE BOARD OF PUBLIC ROADS
SPECIAL INFORMATION FOR INSPECTOR (SKETCHES)
CONTRACT NO. 1903 LOCATION Smithfield-Glocester (Putnam Pike) 1919 Reconstruction
MADE BY G.H.H. DATE 4-3-19
CHECKED BY F.H.W. DATE 4-3-19
Center Grade
Stone Fill
Typical Section to be Employed where Stone Fill is called for on Grading Diagram
Gravel
Typical Section to be Employed where Stone Fill over Gravel is called for on Grading Diagram
Gravel Foundation
Typical Section to be Employed where Gravel Foundation is called for on Grading Diagram
Typical Section to be Employed where neither Gravel nor Stone Fill are called for on Grading Diagram
12" Gravel Foundation
Section to be Employed across Longhouse Fill
Standard 5' Cobble Gutter with Header
(See Section 12 of General Specifications)
CONTRACT NO. 1903
PLAN NO.
CASE NO. C
DRAWER NO. 19-34

TYPICAL ROAD SECTIONS, DEPTH OF BASE DEPENDENT UPON FOUNDATION

We find that the most satisfactory method of determining the compression is to lay a short section and roll it. We believe in securing an even surface upon our stone foundations. The taking care of pronounced irregularities in the surface of the stone foundation by varying considerably the depth of the bottom course of crushed stone is not considered either good construction or economy. It is a good plan to accumulate a considerable supply of the smaller sizes of stone to fill depressions which develop in rolling, and to fill the depressions with this material before the surface is packed too hard. Rolling of the stone foundation is continued until there is no noticeable movement under the roller. Fracture of the stones in the surface always results from rolling to the extent which we deem necessary. After our stone foundations are rolled and the voids are filled with gravel the surfaces are usually sufficiently smooth to ride over in a mtor vehicle in comfort at moderate speeds.

There should be a close relationship between the establishing of grades and the design of foundations. If it is possible in places to avoid excavation for foundations in the establishment of grades, the resulting economy makes this course practicable. It sometimes happens also that a thin stratum of unstable sub-soil underlaid by good material may be taken care of without the necessity for foundations by establishing a grade which involves excavating the poor material. It is not desirable furthermore to establish grades finally until the foundations are designed because excavation for foundations affects the quantities considerably and influences the balancing of quantities.

The design of foundations does not appear to us to be a definite science. It is a matter of judgment to determine the proper depth required. Our foundations vary in thickness from 6 in. to 18 in., depending upon conditions.

It is not to be presumed that foundations are placed under all of our penetration roads. If the sub-soil consists of sand or gravel offering perfect sub-drainage, we never plan foundations.

There never has been an instance where uniform

foundations were planned for the entire length of one of our sections of road, even though we have built many sections only one mile in length.

All information regarding foundations is furnished the resident engineer. There are cases occasionally, in new construction work particularly, where the matter of foundations at certain points is not definitely settled until rough grading has been finished, but the resident engineer's information sheet calls upon him to notify the office when the rough grading is done so that the engineer designing the foundations may determine the best course to follow in regard to foundations. We find that a foundation diagram is a very simple way of providing information for the resident engineer. This diagram consists merely of a straight line indicating the center grade, below which are shown in diagrammatic form the details of the foundations upon the entire contract. Station numbers indicating the limits of the various types and depths of foundations are placed over the line representing the center grade. This grading diagram we consider a more ready reference than notes stating what the foundations are to be from station to station. Typical cross-sections also are included in the information provided the resident engineer. We attempt to include upon the resident's engineer information sheets every detail concerning drainage and foundations. The grades and directions of special drainage ditches, for instance, always are provided.

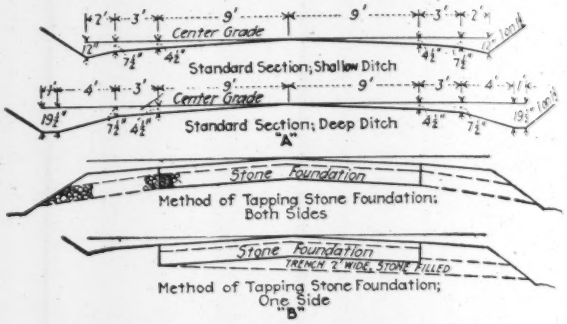
Advantage in Planning Foundation

One of the chief advantages of planning foundations in advance of letting the contract is that the contractor knows definitely where all of the foundations are to be placed and can, previous to the making out of his bid, make definite arrangements for the securing of the required amounts of material. There is very little variation always in the foundation quantities contained in our proposals and the final computed quantities. We consider also that the design of foundations and of drainage facilities is of sufficient importance to warrant attention by engineers of long experience in this class of work. We do not deem it advisable to allow our resident engineers to determine anything in regard to the locations, character and depth of foundations.

Our plan of careful design of foundations has proved to be very effective, since we have not as yet noted a single instance of foundation defects developing after the completion of a road. We deem a standard foundation for a given road very poor judgment, in view of the conditions which have to be met in Rhode Island. Each individual fault in the sub-soil should, we believe, be considered as a separate problem to be solved separately. A standard foundation furthermore would have to meet the worst condition and would be far heavier than would be necessary for the remainder of the road.

Our ditch or gutter sections vary considerably in order to meet varying conditions. We employ two standard typical ditch sections, but special ditches are common. The shallower standard ditch section is employed as a rule where the sub-soil conditions are favorable, so that deep foundations are not needed, or where drainage of the foundations may be accomplished at frequent intervals in fill sections. This section involves a gutter 5 ft. wide and 7 in. below the edge of the pavement at the outer extremity. The gutter slopes for the first three feet at the rate of 1 in. per ft. and slopes for the remaining two ft. at the rate of 2 in. per ft. The deeper ditch section is 8 ft. wide and has a maximum depth below the edge of the pavement of 15 in. at the outer extremity. The latter section is employed where particularly adverse sub-soil conditions prevail.

We do not deem it necessarily essential to employ a ditch section which involves an elevation of the bottom of the ditch below the bottom of the foundations. We never drain our foundations at intervals less than 300 ft. and frequently no drains are provided for intervals of 1000 ft. or more. Our plan of intercepting water before it gets into the foundations where decided flow of water exists makes very frequent taps into the side ditches unnecessary. A most careful observation has



A, STANDARD DITCH SECTIONS; B, METHODS OF TAPPING STONE FOUNDATIONS

yet to disclose a single instance of perceptible flow of water from the taps leading into our foundations. We always place taps, however, at low points in grades and in fill sections upon long grades.

The same attention to foundations and drainage is given to projects involving types of construction other than bituminous macadam.

Construction Costs

Total costs of road projects vary greatly even though there be little difference in the costs of the paving surfaces. The costs of grading, of foundations and of property damages are subject to great variation. It is deemed therefore advisable to separate here the costs of the pavement proper from the total costs.

The costs of the pavement proper as given below include no engineering cost, no costs of grading and no costs of foundations and drainage, but include only the cost of the items entering into the construction of the pavement proper, including the cost of the base course of crushed stone.

In 1913 the costs of the pavement proper varied from $0.76 to $1.11 per square yard and averaged $0.90 per square yard. The total costs of work done in that year varied from $0.83 to $1.38 per square yard and averaged $1.09 per square yard. The bituminous macadam roads built in 1913 are not characteristic of our bituminous macadams in general, because they were in large part laid under conditions requiring little foundation cost and because rather inferior crushed stone was used in some cases. These roads also were built with one exception to a uniform width of 14 ft., while our bituminous macadams built since that time are in general 18 ft. in width except upon curves, where the surface is widened.

No bituminous macadams were built in 1914, because our funds in that year allowed of general maintenance only.

In 1915 only two sections of bituminous macadam were built, since our funds in that year also were very meager. One of these roads was built at a cost of pavement proper of $0.62 per square yard and at a total cost of $0.78 per square yard. The costs of the other road built in 1915 were $0.86 per square yard and $1.10 per square yard, cost of pavement proper and total cost respectively. Trap rock was employed upon this work exclusively. As the figures indicate, however, the costs of grading, foundations and drainage were relatively low. The sub-soil conditions encountered in building these roads were very satisfactory.

In 1916 a total of 20.35 miles of bituminous macadam were built. The conditions encountered in this work varied greatly, as the costs indicate. The costs of pavement proper in that year varied from $0.82 per square yard to $1.42 per square yard and averaged $1.16 per square yard. The total costs of this work varied from $1.02 per square yard to $2.11 per square yard and averaged $1.58 per square yard. Common labor costs averaged 20c. per hour in 1913 and 1915 and 25c. per hour in 1916.

All of the bituminous macadam built from 1913 to 1916 inclusive was done by contract. The costs given therefore are not actual costs, but are the costs to the state.

A considerable amount of bituminous macadam has been built since 1916 both by contract and by convict labor. Costs of this work since 1916 have of course increased, as have the costs of all types of pavements. Since costs of construction are of little interest without costs of maintenance, for a few years at least, and since the roads built since 1916 are so recent that maintenance costs are of little interest, no costs of later work are given.

Maintenance Heaviest First Year

The maintenance of our bituminous macadam roads has to date been slight. As a rule our maintenance costs the year following construction are greater than they are each year for several years following. The most careful supervision will not avoid absolutely minor faults in the distribution of the bitumen. These faults are apparent the year following construction, and that is the time to take care of them. Upon roads finished late in the fall the maintenance the year following construction always is greater than is the case of a road finished earlier in the season.

In our maintenance of bituminous macadam roads we believe that the same type, quality and consistency of bitumen should be used as was used in construction. We do not favor the use of light patching compounds except in case of emergency during the winter months. All of our maintenance of bituminous macadams is carried out by the section gang scheme. Each section gang is equipped with heating facilities and with a small tandem roller so that repairs may be made under conditions substantially the same as the road was built under. Aside from cuts in the surface by public utility companies we have very few holes to repair and it is therefore very often possible to omit the tandem roller from the equipment. Most of our maintenance of our bituminous macadam consists merely of painting over spots which look porous and covering with clean ½-in. screenings. A considerable portion of our total cost of maintaining bitminous macadams is occasioned by inadequate drainage of surface water upon car tracks adjacent to the metalled surface. Our law does not permit us to exercise compulsion over street railway companies in the matter of drainage of surface water and we are not allowed under our law to drain the tracks at our expense. It is necessary for us to ask the aid of township and city authorities in order to have the traction companies do the work necessary from our standpoint, and this plan is not efficacious in bringing about results. As an example of this sort may be cited an instance of a road 2.2 mi. in length and containing 22,862 sq.yd. built in 1915 which has cost to date a total of $194 to maintain, of which approximately 75% has been occasioned at one point where the drainage from the street railway tracks was so inadequate that the pavement was covered with water and ice during the greater part of each winter.

As has been stated previously none of our bituminous macadams has as yet required re-sealing. It is unfortunate that accurate costs of maintenance of the bituminous macadams built in 1913 are not available. These sections were in every case very short, and under our old cost-keeping system the cost of maintaining these sections was included in the cost of maintaining longer sections of which these particular sections were a part. One of the sections built in 1913 has required absolutely no maintenance of metalled surface to date. In no case has the maintenance cost been over $100 per mile per year and the average cost of maintenance we estimate to be less than $50 per mile per year.

Maintenance Cost Data

The total average cost to date of maintaining the bituminous macadam roads built in 1915 is $0.017 per square yard, or $179 per mile. The average total cost to date of maintaining the roads built in 1916 is $0.019 per square yard, or $201 per mile. The total annual costs of maintenance of the roads built in 1916 is of interest in showing that the maintenance the first year is larger than for a few years following. No maintenance of the roads built in 1916 was carried out during that year. In 1917 the total cost of maintenance of these roads was $2300.11, in 1918 the total cost was $1049.99 and in 1919 the total cost was $750.61. Of the total of $2300.11 spent in 1917 for maintenance of the roads built in 1916, the amount of $1148.48 was spent upon one section two miles in length and containing 20,209 square yards. This road was finished very late in the season of 1916 and for that reason the results were rather inferior. It is, however, gratifying to note that the maintenance costs of this road in 1918 and 1919 were $55.03 and $37.33 respectively. Increases in the cost of labor and of materials during the period in which the total costs of maintenance of our 1916 work are given cause the relative costs in the separate years to be less than they would have been otherwise.

Since our experience with bituminous macadam dates from 1913 only and is therefore recent, the above costs are not perhaps of special interest, because the roads have not been down long enough yet to require re-sealing. What the annual cost for re-sealing will be remains to be seen. The surfaces at present appear to indicate that re-sealing of none of our bituminous macadams will be required for several years to come, but time only will prove it. Observation of our older cold mixed roads indicates that a road of that type which gives good service at slight expense for three years

can be maintained at slight expense for at least ten years. Whether or not the same condition applies to our bituminous macadams is a question we cannot yet answer.

None of our bituminous macadam roads has waved perceptibly so that it does not appear that there is danger from that cause.

Traffic

Our bituminous macadams have been laid upon some of our heaviest main trunk lines. Some of the roads upon which we have laid bituminous macadam successfully are as follows: Post road from Providence to Westerly via Narragansett Pier, the road between Fall River and Newport, the road between Providence and Fall River, the road between Providence and Woonsocket, the Putnam Pike, the Hartford Pike and the New London Turnpike. The section of bituminous macadam carrying the heaviest traffic in point of number of vehicles is upon the post road between Providence and East Greenwich. This road carries an average daily traffic of approximately 3500 vehicles of which 97% are motor driven. The motor-truck traffic over this road is approximately 300 trucks per day. The Mendon Road between Providence and Woonsocket, upon which we have laid bituminous macadam, carries an average daily traffic of approximately 1800 vehicles, of which 600 are motor trucks.

Summary

The writer is of the opinion that bituminous macadam properly laid is an economical pavement under certain conditions. There are of course a great many points to consider in the selection of type of pavement for a given highway. It is not deemed within the province of this article to enumerate or to discuss these points. It is of course not sufficient to compare alone first costs. A comparison between ultimate annual costs should be attempted.

In Rhode Island we frequently are called upon to select pavements for use in sections far removed from railroad facilities and in which the local rock is of poor quality. The use of the inferior local rock in bituminous macadam construction is not considered, but a bituminous concrete of mineral aggregate consisting of local sand or gravel laid over a base of the local rock crushed to large sizes, or cement concrete, is selected.

It is beyond question that a great deal of bituminous macadam has given poor service. It is also doubtless a fact that much bituminous macadam has been laid without due regard to selection of materials, to design of foundations and drainage facilities and to construction details. It appears that many of the common faults of bituminous macadam, however, may be avoided.

Geological Survey's Work

The United States Geological Survey during the year which ended June 30, 1919, according to the annual report of the Secretary of the Interior, mapped more than 10,000 square miles of territory in the United States, laid more than 4000 linear miles of primary traverse and more than 4000 linear miles of levels, and established more than 2000 permanent bench marks, occupying 61 triangulation stations and permanently marking 50 stations.

Drainage for Irrigated Land in Yakima County, Washington

Saturated Soil Like Quicksand—Construction and Maintenance Under County Engineer—Pay by Warrants and Bonds

BOTH drainage and flood protection are required for land reclamation in Yakima County, Washington, the former being entirely for the improvement of land that has become waterlogged and covered with alkali owing to lack of outlets for irrigation waste water. Levees or dikes are needed as protection from high water in the Yakima River and to prevent changes in the river channel during high water. As Yakima County has the largest irrigated area in the state, its drainage problem is important, and it was largely instrumental in securing the passage of the present state law, in 1913, under which it has established the office of drainage engineer for the county. Since then it has built 74 miles of open ditch and 78 miles of pipe drain laid with open joints. The total cost of drainage work for about 85,000 acres is about $1,030,740.

Under the Washington law, property holders desiring drainage file a petition and bond with the county commissioners, who order an investigation by the county drainage engineer. If this is favorable, a location survey and report are ordered, the report being then discussed with the property owners at a public hearing. If the project is approved, the works can be carried out by contract under the county commissioners or by force account under the board of supervisors elected by the people within the district. In either case the administration is left to the county engineer.

Payment is made by temporary warrants until the improvement is completed, after which bonds are issued and the warrants are called in. This has proved a successful method of financing, as the local banks or the bank with which the contractor does business are usually willing to carry the warrants, which bear 8% interest. All work was done by contract until the summer of 1917, when changes in the labor and material markets made this undesirable. A cost-plus system was then established, with satisfactory results.

Soil conditions make the work difficult, as most of the excavation is in volcanic ash, which when saturated is very similar to quicksand. In trenches a foundation for the pipe is often necessary, gravel being generally used for this purpose, in amount varying with the degree of saturation. With open ditches the main difficulty has been the caving of the sides, but this has been reduced largely by excavating with dragline machines to give the cross-section required by the specifications. Material which slipped after the first excavation was moved by sluicing with irrigation water, as the cost of bank-protection work was prohibitive.

In the drainage law the county engineer is defined as an engineer specially employed for this purpose by the county commissioners, but Yakima County is believed to be the only one that has appointed a drainage engineer to look after this work exclusively. This office is practically a permanent institution, since the law makes the drainage engineer a member of the board of supervisors of each drainage district and each diking or levee district, while he also acts in an advisory capacity in the maintenance of all works constructed. J. O. Greenway has been county drainage engineer for some years, with office at Yakima.

Classification and Uses of Highways and the Influence of Federal-Aid Acts

An Address Before the Louisville Convention of the American Association of State Highway Officials, December 10, 1919

By Thomas H. MacDonald
Chief of the Bureau of Public Roads

A CAREFUL definition of the problem set up by this topic is essential to its discussion, and such a definition rests entirely upon a careful scrutiny and analysis of the uses which we are now making and which we will make in the future, of our highways.

These uses may be defined roughly in four general classes: (1) those uses chiefly related to agriculture; (2) those which are recreational in character; (3) those which are commercial, and (4) those which are military. It is believed that these uses are placed in the order of their importance as determined by their respective volumes, considering traffic in the aggregate for all of the 48 states. Admittedly, there are sections, perhaps of some considerable area, in which the ranking order of these classes would be changed, but conceding this, it does not modify the principle that the roads which we are building must serve these four classes of traffic, and that a failure to provide adequately for any one of these classes means a shortcoming, at least, in the methods adopted by both the states and the nation; so those laws which we now have must be judged in the light of the degree to which they are now providing, or, if given sufficient time, will provide, for these classes of traffic; and certainly provision for these classes is the whole object of the enactment of either state or national highway laws, or the establishment of state or federal highway departments. This statement should be reiterated until the attention of road builders is focused upon the proper objective. It sometimes would seem that we are likely to lose sight of the object we are attempting to obtain in discussing the manner or the means through which we shall operate, and at such times it seems highly desirable to analyze in some detail the uses of the roads for which we are attempting to provide.

Agricultural and Recreational Uses

The first class—those uses related to agriculture—includes the town to farm and farm to town traffic characteristic of the more purely agricultural districts; the country to city and city to country traffic, which is fast growing and highly important where adequate roads have been built radiating into the country districts from the large centers of population; and the traffic carrying crops or foodstuffs from productive areas which are isolated from rail transportation. Under this class should also be included the social, educational and religious activities which produce traffic from the farms to the schools, to the churches, and to the community centers.

The second—the recreational class—includes two distinct types of traffic, local and tourist. Local recreational traffic is continuous, and is not definite in its character. The automobile has been the means of combining a great deal of business and pleasure traffic, and of the two kinds of recreational traffic the first is far more important, because it affects so large a percentage of our population. The recreational value of the continuous outdoor driving and the increased social intercourse which has resulted can scarcely be estimated in their effect upon a large percentage of the population, whose social and recreational activities up to the advent of the moderate-priced motor car were very limited.

The tourist traffic is a growing and highly important one, and this growth should be enlarged by providing adequate roads, so that inter-state and transcontinental traffic will be encouraged. There is not a single state in the union that does not possess localities of interest to the population both within and without the state. There is perhaps no better way to promote a broad Americanism than to make it possible through the building of roads, for the people of one state to know in a more or less intimate way something of the worth and beauties of the neighboring states, and this interest and knowledge should be sufficiently extensive to take in the national parks, forest areas, former battle-fields, and the many points which, through historical association and tradition, or because of their natural characteristics and environments, hold much of value to every man who places his country above all others. While traffic that may be included under the term "tourist" is fast growing, it is very small in comparison to the other recreational uses that are being made of the roads, and it is impossible now to foresee that this class can ever be more than a minor percentage of the local recreational use of the highways. During the season of 1918, 54,596 private automobiles entered the 11 national parks, while during the same season approximately 450,000 people visited these same parks. These figures may be taken as indicating something of the tourist travel by highways when it is considered that a large amount of our western automobile travel makes the national parks its objective; but considering that this traffic is spread over a period of several months, it will be seen that if all of the automobile travel were confined to a single road, it would then only equal a daily traffic equal to that on many country highways outside of the influence of any large city, and would not begin to compare with the traffic on our heavy traveled thoroughfares in populous districts; but considering that the total number is spread over many western roads, it will be seen that this traffic is only incidental to the local uses which are made of the main thoroughfares.

Commercial and Military Uses

The third class—the commercial use—is not strictly defined by this term, but as used in this discussion refers to the traffic on the highways resulting from the transportation of commodities between centers of population as differentiated from the collection of crops and distribution of commodities in the rural districts. This class of traffic would cover the carriage

of commodities, much of it in package form, which now makes up the bulk of the short-haul freight and express. No doubt there will be a very large increase in this class of traffic on the highways, but the traffic which developed during the war is not normal and will not continue as the normal conditions reassert themselves. Just what will be the length of haul which, because of its economy, will go to the highways, has not yet been determined, but the only studies made by the Bureau and these during the period of the war, indicate that 100 mi. seemed to have marked the limit of such hauls. Even conceding that this class of traffic will develop very largely, it must of necessity be confined to those areas where the terminal points consisting of comparatively large centers of population are close enough together to allow at least daily one-way trips to the unit of transportation used.

The fourth—the military uses of the highways—is given fourth place not because of its lack of importance, but because the probable strictly military significance of the highways has been very considerably misunderstood. Any system of highways which will serve the first three classes of traffic will adequately serve the military requirements, except in certain particular areas. In such areas, the highways must be provided which are demanded by the military authorities as a part of their plans for their military operations, but it must be accented that military highways as such are confined to restricted areas, and outside of these so-called vital areas, any system of highways that adequately serves the agricultural and commercial traffic will serve also the military purposes in either war or peace times. If, therefore, it is conceded that practically all of the traffic which we are now carrying on the highways has been defined in the foregoing classes, it is at once evident that, with the single exception of tourist traffic, the uses of the roads are largely local. There are no traffic counts which have been made sufficiently extensive to indicate that a general statement may be arrived at correctly representing by percentages the use of the roads that are local. Those traffic counts which have been made would place this use as high as 90% to 95%, and it is very questionable if this percentage will increase very materially even as the roads are improved, for, although the total traffic on improved roads increases rapidly, it is doubtful if the average daily local traffic will fall below 90%, except on those roads which, because of their particular location, are built primarily for tourist travel.

These statements, it must be remembered, are intended to be very general in their character, and to cover the country as a whole, but it must be conceded that more than 90% and possibly more than 95% of the demand for better highways, arises from the local need for such improvements. The development of a national highway system must, therefore, take this fact into consideration, as opposed to the development of a system of national highways. There would be no advantage gained by considering the local uses of the roads as secondary. No plan of administration predicated on such an assumption can prevail, because it is an economic fallacy. That there is a demand for better facilities for tourist travel there can be no doubt, and that there is an increasing demand in localities for better facilities for through transportation of commodities is equally apparent, but that these needs now justify national intervention solely in their behalf, or that they are of such a nature that they cannot be met by a properly planned national system of highways, is open to serious question.

There is no evidence of fact shown by traffic counts or any highway use of importance, that justifies a presumption that a need of national consequence is being overlooked. We must meet, in the development of our highway systems, the economic needs of the nation for highways in the order of their importance. That these highway systems must be laid out along sane and sound economical lines is all the more important when it is evident that such a procedure will eventually produce systems of highways suited to the special needs of each locality, and yet be entirely adequate to meet all the requirements which those who are particularly interested in a system of national highways specify.

Rural Life and Roads

At the present time there is no more important problem confronting the American people than that of increasing the comfort and desirability of rural life, thereby stimulating the production of food products. Of equal importance to this is the necessity for providing better methods of distributing food products—and especially the perishable food products—to the consumer without loss of time and without these products passing through so many hands between the producer and the consumer.

Federal intervention through federal aid, if of assistance to these ends, is reasonable and proper from such standpoints alone; indeed, such intervention may be said to have become imperative. The city population of this country has for years been growing rapidly, while the growth of the rural regions in many places has been negligible and too often has actually been negative. The towns have held too many attractions in the way of social, recreational and educational advantages, but through the use of the motor car in conjunction with improved roads, these advantages in favor of town life can be largely overcome.

Beyond any doubt the war accented the need for more and better highways during the period of rail congestion, but if there is one need that the after-war conditions have brought close to every individual in the nation, it is a need for an adjustment of conditions that will allow people to be properly fed and clothed within the limits of their incomes. So far as improved highways will help to accomplish this they certainly will be held to fill a great national need. The population of the country has more than doubled since 1880. At that time only a little over 30% of the population was recorded by the Census Bureau as urban, or some 16,000,000 out of a total population of 50,000,000. Today out of a total population of approximately 105,000,000, about half, well over 50,000,000, are urban dwellers. The effect of this condition is reflected in production figures. In 1880 the production of wheat was about 450,000,000 bu. per year, while during the period prior to the war it was only slightly over 700,000,000 bu. Similarly, in the case of corn, the production in 1880 was about 1,700,000,000 bu., while prior to the war it was about 2,500,000,000 bu. War conditions as to production were abnormal, so pre-war figures have been used instead of the later figures. From these figures it appears that the produc-

tion of food has increased about as the rural population has increased. It is true that there has been some gain in the production of the individual on the farm, but the fact still remains that the total population has been increasing much faster than the rural population, and any effort that the Federal Government can make to improve rural conditions that will insure a sufficient rural population, and to provide means for bringing the producer and the consumer closer together, is justifiable. From this standpoint alone Federal aid for roads certainly can be considered to be at this time a great national assistance in solving one of the greatest of our national problems.

Results of Federal Aid Law.

The results accruing from the Federal aid road law up to the present time cannot fairly or honestly be reckoned in the number of miles of finished road because of conditions prevalent during the period from which we are just emerging. The big result, so outstanding as to overshadow every other consideration, which can be primarily credited to the Federal Aid Road Act, is the amount and character of advanced road legislation which has been written into the laws of every one of the 48 states. These laws, in connection with the Federal Aid Road Act, have established on a firm basis, with adequate support funds, highway departments in all of the states which did not have highway departments prior to 1916. In the states which had highway departments prior to that time the legislatures have enlarged and strengthened the authority and increased the support funds of those departments. This legislation has in general provided for more than the building of Federal aid roads, and in some of the states has included provisions for the building of the roads from the greatest to the least important. In addition to the legislation great sums of money have been made available through the levying of special or general taxes and through the authorization of bond issues. The Federal aid law should not be credited entirely with this changed viewpoint on the part of the public, indicated by the availability of such large sums, but it can be credited with appealing in a most forceful way to that characteristic of the human race—willingness to exert itself to secure some award. Probably without Federal aid the conditions after the war and the changed attitude of the public generally toward public spending on a large scale would have made themselves manifest, but certainly the Federal Aid Road Act can be credited with having turned the attention of the public toward the expenditure of public funds for highway purposes. It was not possible to go ahead with the actual production of roads on any considerable scale during 1917 and 1918. During the present year a large mileage of roads has been placed under contract. The production has still been disappointing due to conditions which are now well understood. However, during this period there has been a remarkable development in the fixing of systems through the classifications of roads, so that now we have in each state a system of main or state roads more or less definitely fixed, and in many of the states other systems of lesser degrees of importance. Many of these systems have been worked out very carefully and painstakingly. In fact it is doubtful if the highest administrative and executive officers of the State highway departments have devoted as much of their personal attention to any other single phase of the highway work as they have to the actual classification of roads. For the last three years this has been perhaps the chief and most important work that these men have accomplished, and its importance should not be understood.

Classification of Roads.

The proper classification of roads is basic and fundamental. It has been demonstrated in those states which have carried out this classification in a careful, thorough maner, that people acting through their state legislatures have provided the ways and means for carrying out the program of improvement in accordance with the importance of these roads. Let it here be clearly understood that the people of this country will support a policy of road building which is based on their economic needs. It has been pretty well demonstrated in individual states that the mileage of the primary state roads cannot be restricted to too small a percentage of the total. Most of the states have found it necessary to add a considerable mileage to their original conceptions of an adequate system, and where this action has not been initiated by the State Highway Department itself, it has resulted through legislative action. It has been pretty definitely established that a system of primary roads must be sufficiently extensive to give service to all parts of the state. It is thereby safe to fix the percentage without further inquiry, but it seems evident from the result in states which have made a careful study of their economic needs, that in the neighborhood of 5% to 7% of their total mileage will be included in their primary systems. This percentage may change slightly for the nation as a whole. Unquestionably at the present time Federal aid should be restricted to the State systems, and since it is true that the State primary systems can in general be divided into roads of first and second importance, it might serve the economic needs of the states to confine Federal aid expenditures to the roads of the first class in the primary system. It is likely that this will be more possible in the older states than in the newer states where it is absolutely necessary to develop a considerable mileage of roads in order to give the people access to all of the different sections of the state. That is, there are some sections in which a smaller mileage of high class roads is necessary to meet the traffic demands, and there are other sections in which a longer mileage of cheaper roads will as adequately serve the traffic needs, and which is the only policy that the public will support at the present time.

Connecting the Primary Systems.

The step which seems necessary now is a definite plan of co-operation between the states and the federal government, which will insure that the primary system of each state be connected up with the primary systems of the adjoining states, and that these systems, by agreement between the state and federal authorities, be held to until they are properly improved.

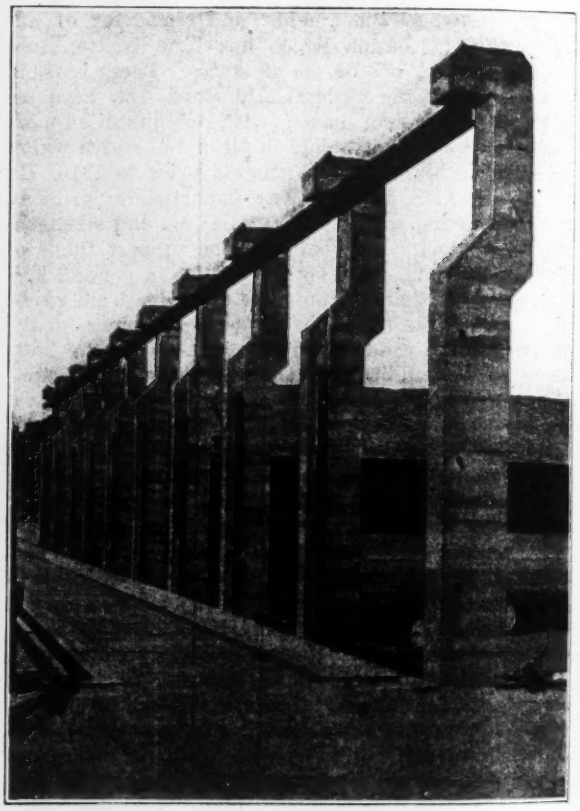
Up to the present time the Bureau of Public Roads has made its objective the perfecting of the administrative relations with the states. These relations have in general been placed on such a basis that better engineering standards can be developed and enforced, and it is undoubtedly a duty of the Federal

Bureau to stand behind the states in their efforts to provide roads that will be adequate not only for present traffic, but for future traffic. This point is of great significance, particularly in those states where roads are being built from bond issues and where it is doubtful if adequate maintenance funds will be provided for those types of roads which will require high maintenance costs. It is true that the Federal aid act requires the greatest co-operation between state and federal authorities in order to make the plan outlined by the law an efficient method of operation, and yet it has as its fundamental basis a plan of action that will have to be used more and more in carrying out large public or private enterprises that are undertaken in this country, and the sooner this fact is recognized and put into operation the better it will be for the industrial life of the nation.

There is now comprised in the 48 state highway departments and the federal department a very large proportion of the engineers of this country who have had actual highway experience, and these agencies can, through co-operation, provide the most effective administrative organization that it is possible to devise. The fact that a considerable portion of these administrative officials are in close contact with the public in all the different localities of the nation, insures the development of the roads which will answer the greatest economic needs. In the law itself there are certain modifications which undoubtedly should be provided for in the extensions of appropriations for carrying out this act. One of these is the $20,000 per mile limitation, which is not now so much of a handicap but may later become so. There are roads being built where the grades themselves, because of the topography, will cost without surfacing nearly up to the limitation now imposed by the law. After these road grades are properly settled they should be surfaced where the traffic justifies. In many of the sparsely settled western states there are large areas of federally owned lands through which the state systems must be projected, and in many cases the roads through areas of this character are necessary links in trans-state or trans-continental lines. To prevent an undue burden falling upon the states which can ill afford to build such roads, consideration should be given to the extension of the appropriations which are now made for the building of roads in the forest areas. These roads in general are of two classes—those which are necessary for the administration of the forest areas themselves, and those which form important links in the state systems. Again, there are roads notably in the western states but found also in some other localities, which are of greater importance as links in trans-state or trans-continental lines of travel than they are to the immediate locality. If the states in which such roads occur follow a program of providing first those roads which meet the greatest economic needs of their people, some of the through roads will necessarily be delayed for some time, and the advantage of a long line of improved roads on either side may be largely lost because of stretches. To take care of cases of this kind consideration should be given to a provision which will allow the bearing of a greater part of the cost from the Federal aid funds than the 50% now specified. Such a procedure would undoubtedly be fair and reasonable, but if adopted it should be carefully restricted and guarded so that the roads which ought to be improved as links in long lines of travel will receive first attention. These points summarize the most important modifications which it seems now necessary to make in order that the present Federal aid law through co-operation between the state highway department and the Federal Bureau of Roads may meet satisfactorily the national need for improved roads, and insure the completion of roads in the order in which they meet the economic needs of the individual communities and thus of the whole nation.

Offset Cantilever Gate Hoist Support

Concrete columns with an offset at the top support a rail on which a trolley gate-raising hoist runs directly over the centers of the headgates of the outlet of Utah Lake into the Jordan River. The offset, as shown in the photograph, is long enough to give clearance for



CANTILEVER EXTENSIONS SUPPORT GATE HOIST

the trolley to pass from one gate to another. Bolts through the cantilever support the I-beam track. This structure was built during the winter, and the concrete was protected by tar paper wrapped around the forms, steam being let into the 4-in. air space between the form boards and paper. The work was carried out by W. A. Knight, superintendent of the nearby pumping station which pumps water over the bar into the river when the water from the lake is drawn down below its natural outlet.

Earth Slips Prove Disastrous to Open-Cut Sewers

Bank Slides and Bottom Upheavals Interrupt Work on Two Detroit Sewers—Revised Methods Correct Trouble

EARTH movements of significant character have occurred in recent large sewer-construction operations in Detroit, Mich. In three instances the consequences have been disastrous. Two of the movements were plain bank slides. The third was a true bottom upheaval resulting from a subsurface flow of plastic material with very slight disturbance of the original banks. Control of open-trench excavation and backfilling has been tightened up as the result of the accidents, and the already prevailing tendency of local contractors and public-works officials toward tunneling methods for sewer construction has been strengthened.

Topographically, the site of Detroit, Mich, is a comparatively smooth plain, rising gently from and not to a great height above the river level. Geologically, this plain is an old lake bed. At a depth of 90 to 150 ft. there is glacially scored limestone ledge. Above this comes a "blue clay" to within 11 to 13 ft. of the surface, and finally a stiff yellow clay with a topsoil of vegetable mold.

The yellow clay covering is hard and firm and forms a strong crust over the more plastic "blue clay." In some parts of the city it has been used largely for making brick. The "blue clay" has physically all the characteristics of a true-blue clay, but chemically it is not clay. Just under the yellow clay crust, for a depth of 17 to 20 ft., it is quite stiff, and then it becomes softer and more plastic. In parts of the plain, sand pockets and lanses are interspersed with the clay. When the clay runs uniform it contains some water, but it is remarkably impervious to the passage of water. It is at various depths in this "blue clay" that the greater part of Detroit's sewers have to be constructed.

Two of these sewers now in progress, the Lonyo Road sewer and the Weatherby Ave. sewer, are the operations on which the earthslides mentioned have occurred. The Lonyo Road sewer is a twin box sewer, with dished inverts and outside dimensions of 32 x 17¾ ft. The Weatherby Ave. sewer is a five-center arch, 24⅝ x 15¼ ft. over all. Both structures are of reinforced concrete, and were located in the "blue clay" below the yellow clay crust.

Lonyo Road Earthslides

Construction of the Lonyo Road sewer was begun at the lower end. The contractor's plan was: (1) To excavate trench by dragline excavator well in advance of the concrete work; (2) to build the invert well ahead of the box walls and roof; (3) to concrete walls and roof with movable steel forms, and (4) to backfill with a second dragline excavator.

A trapezoidal trench, without sheeting or bracing, was opened as indicated by the diagram Fig. 1. The first slide occurred when about 130 ft. of trench had been excavated. It was a plain bank slide which raised the bottom of the trench about 8 ft. for a distance of 50 or 60 ft., as indicated by Fig. 2. The slipping bank crowded up the trench bottom, but there apparently was no true soil upheaval from below. At the time of the slide, July 9, 1919, the trench had stood open about two

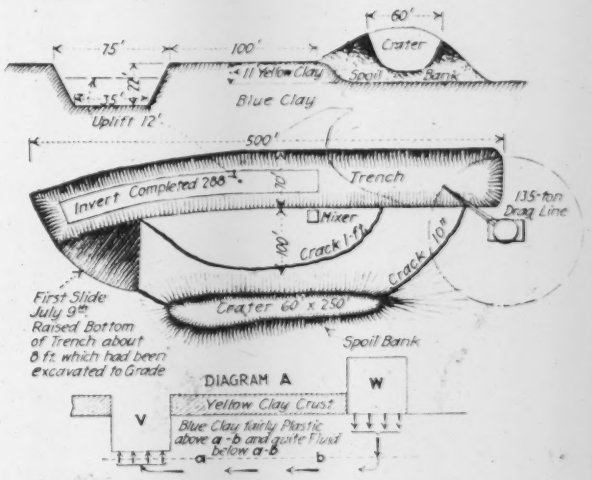


FIG. 1. PLAN OF BOTTOM UPHEAVAL IN OPEN-CUT SEWER

weeks, with the spoil bank close to the edge. No concrete had been placed, and the trench was cleaned out and excavation was continued.

As a precaution, after the first slide, the spoil bank was moved back about 100 ft. from the trench edge. It was placed, as indicated by Fig. 1, in the dry put of an old brickyard, where the top crust of yellow clay had been removed for brick manufacture. Except that the spoil bank was shifted away from the trench edge, construction proceeded as before. The dragline excavator,

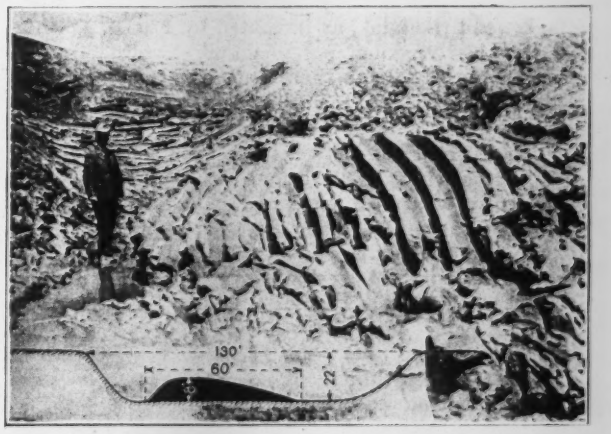


FIG. 2. CHARACTER OF BANK SLIP IN OPEN TRENCH

a 3½-cu.yd. bucket machine weighing 135 tons, worked along the side of the trench. On Aug. 27, 1919, about 500 ft. of trench had been opened. From the south end, 288 ft. of invert had been concreted and another 11-ft. section was being poured. On the completed inverts at the south end a set of superstructure forms had been erected. While work was in progress at 10:30 p.m., the second slide began, and was over in a few minutes.

Examination of the wrecked work showed the results indicated by Fig. 1. The bottom of the trench, with the completed invert, had risen from 3 to 4 in. at the south end to 10 to 12 ft. at the north end. The curve of the elevated invert is indicated by Fig. 3. The slab had been shifted very little out of line, and as shown

FIG. 3. BOTTOM UPHEAVAL LIFTS INVERT 12 FEET

by the view, the bank had not settled down against the edge and brought lateral thrust against it. On the far side the clay from the bottom had boiled up between the invert and the bank, as indicated by Fig. 4. Neither bank edge had changed position appreciably. On the surface of the east bank there appeared two cracks, as indicated by Fig. 1. In the spoil bank a crater had been formed by the sinking of the spoil into the plastic underlying clay. The berm between the spoil bank and the trench had not changed elevation.

Apparently what had happened is indicated conventionally by Diagram A of Fig. 1. The weight W of the spoil bank was transmitted by the plastic clay above a-b to the more fluid clay below a-b. Since clay from the cut weighs 120 lb. per cubic foot and the spoil bank was 22 or 23 ft. high at the peak, the maximum pressure was perhaps one ton per square foot. Under the weight W the fluid clay sought relief in all directions, and relief was resisted in all directions except where the trench V made a gash almost to the fluid clay. Here was a void, and into it the fluid clay rose until equilibrium was restored. Possibly a contributing cause, besides the static loads to mobility of the fluid clay may have been the rocking load brought onto the crust by the swinging loaded boom of the dragline.

Reconstruction of the wrecked work will be undertaken. Meanwhile, the contractor, continuing on from the end of the wrecked work, is building the sewer under a modified plan. Only a very short length of trench is being opened. The invert is then concreted immediately. As soon as the invert has set up, the wall and roof forms are placed and concreted; then as soon as the outside wall forms can be removed earth is backfilled onto the concrete. By thus tightening up the control of excavation and backfilling, the work is proceeding successfully.

Damage to the five-center arch sewer on Weatherby Ave. was much less extensive than to the Lonyo Road structure. Like the larger box structure, it is being

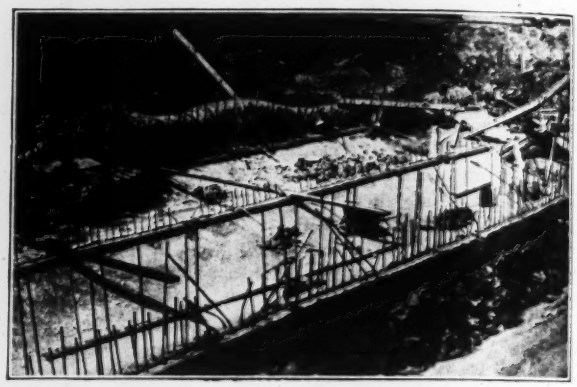


FIG. 4. BOIL-UP OF PLASTIC CLAY AT SIDE OF INVERT

built in open cut excavated by steam shovel and dragline excavator, and a dragline excavator is used for backfilling. The steam shovel makes a cut of 9 to 10 ft., and the dragline, working from the bottom of the shovel cut, completes the trench, which is about 22 ft. deep and 50 ft. wide at the top.

The slide occurred on the night of Aug. 28. It was a plain bank slip, which heaved up the trench bottom

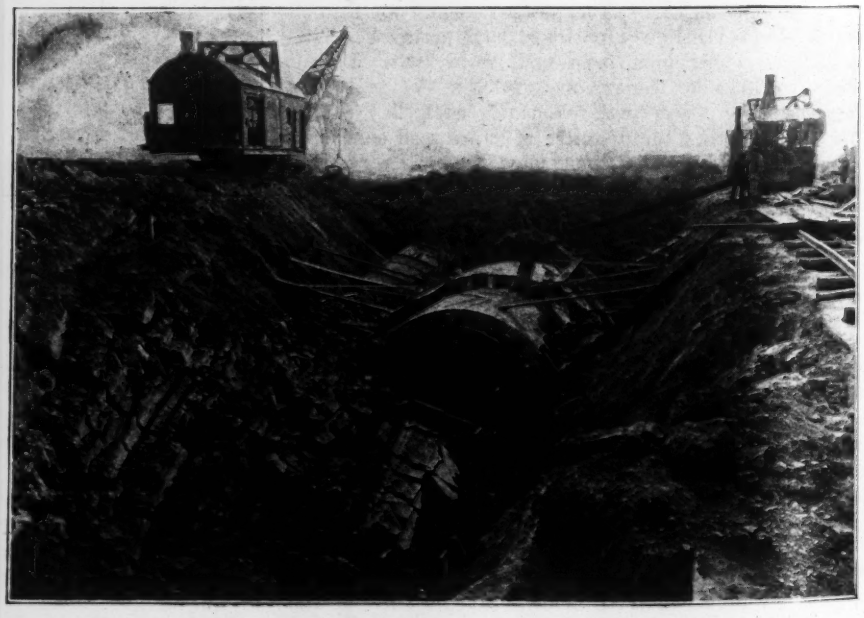


FIG. 5. BANK SLIDE DESTROYS INVERT AND SHIFTS SEWER ARCH

and the inverts completed ahead of the arch, and also shifted sidewise and upward the adjacent completed arches.

The view, Fig. 5, of the cut made nearly 10 days after the accident, indicates the character of the slide, and of the wreck caused by it. The damage has been repaired, and construction is proceeding. Here, as at Lonyo Road, the contractor has constructed his operations and is keeping excavating, concreting and backfilling in close sequence.

Conclusions

In the subsurface soils prevailing in Detroit, the accidents briefly outlined indicate a clear hazard in deep and wide-open sewer construction. If open-cut construction is undertaken, wisdom counsels: (1) That the least practicable length of trench should be opened; (2) that the sewer structure should be constructed in the open trench as quickly as practicable; (3) that a safe weight of backfilling should be placed on the sewer as soon as the outside forms can be removed, and (4) that spoil banks in the vicinity of open cuts should be avoided.

Under other conditions which permit proper cover and an economical section for tunnelling, it is a fair conclusion, also, that tunneling methods promise greater safety than does the employment of open-cut methods.

The work on which the accidents described have occurred is a part of the new public sewer system for Detroit which is being built under the direction of C. W. Hubbell, city engineer.

Reasons Given for High Ocean Freights

Business men engaged in international trade will be interested in an article appearing recently in *Commerce Reports*, by Trade Commissioner Gary, in which he assigned reasons for the very high ocean freights. British newspapers, in commenting upon the situation, assert that one of the reasons is that a ton of shipping today performs, according to well informed British ship owners, approximately half the service it did five years ago—a state of affairs largely attributable to the congestion at various ports in Great Britain. At Cardiff recently 50 vessels were lying idle and others were waiting outside the roadstead. Swansea was overcrowded with 200 vessels, and half as many were at Newport.

Much the same conditions prevailed on the east coast. Other reasons for high ocean rates are labor troubles, increased cost of ships, higher insurance values, higher cost of repairs and maintenance, increases in officers' and seamen's wages, heavier bills for food and ship stores, higher dock dues, and higher prices for bunker coal. Five years ago bunker coal could be obtained in Great Britain for $3.65 to $4.87 per ton. Today bunker coal costs $17.08 to $26.77 per ton, an average price for five British ports being $22 per ton.

Wages have increased more than 100%, and the cost of food and of accommodations has also advanced largely. Furthermore, five years ago it cost between $24 and $29 per ton to construct a vessel in Great Britain, while today the same vessel costs $146 per ton.

Mechanical Engineers Recommend New By-Laws for Student Branches

THE closest sort of coöperation between student branches and the parent body of the American Society of Mechanical Engineers is indicated in proposed additions to the by-laws published in the October number of *Mechanical Engineering*. The changes in the by-laws have been proposed by a special committee appointed to investigate student-branch requirements and to recommend a policy for the conduct of student-branch work.

The committee was headed by Ira N. Hollis. Its report was recently made to the Council of the American Society of Mechanical Engineers.

It was pointed out that the ineffectiveness of the relations existing between colleges and the parent organization seemed due to a lack of definite program, failure to coördinate with student organizations, and a reliance upon the initiative of a few individuals. No material change is made in the autonomy of the student organizations through the proposed additions to the by-laws, the most important of which additions are the following:

1. Each student branch shall annually elect one of its members to serve as corresponding secretary. He may receive a nominal remuneration and expense account from the society. His duties shall be those ordinarily attached to such a position, and in addition thereto he shall be responsible for the maintenance of records and serve as a channel of communication with the parent society.

2. The society shall issue every spring a syllabus or suggestion of some one subject or subjects for consideration for the following year.

3. The authorization of ten scholarships, not to exceed $200 each, to be awarded under rules prepared and administered by the Committee on Relations With Colleges.

4. The setting aside of a fund to be invested in loans for deserving students, to be administered by the committee.

5. The authorization of the necessary expense for sending a representative of the society to visit student branches, preferably selecting one or more members of the Committee on Relations With Colleges for this service.

6. That the Committee on Relations With Colleges be instructed to encourage coöperation among the different branches of engineering in college as well as among the different student branches in the different colleges.

7. That the Committee on Relations With Colleges be instructed to encourage the students to conduct the affairs of the branch themselves rather than to depend solely upon faculty direction or supervision.

8. That the president of the society, either personally or through the committee, be requested to confer with the engineering socieies, looking to coöperative effort in connection with education.

9. That the local sections of the society be requested to interest themselves in the student branches within their localities.

10. That the organization of student branches be left with the Committee on Relations With Colleges, subject to the approval of the council.

11. That, so far as it seems advisable and possible, the society, through its committee, assist the student branches in obtaining from time to time a few good lecturers from the outside.

12. That a student who has done the most effective work in a student branch in his senior year may be elected to junior membership in the society, upon graduation, by the student branch, and that the society remit the initiation fee and dues for the first year.

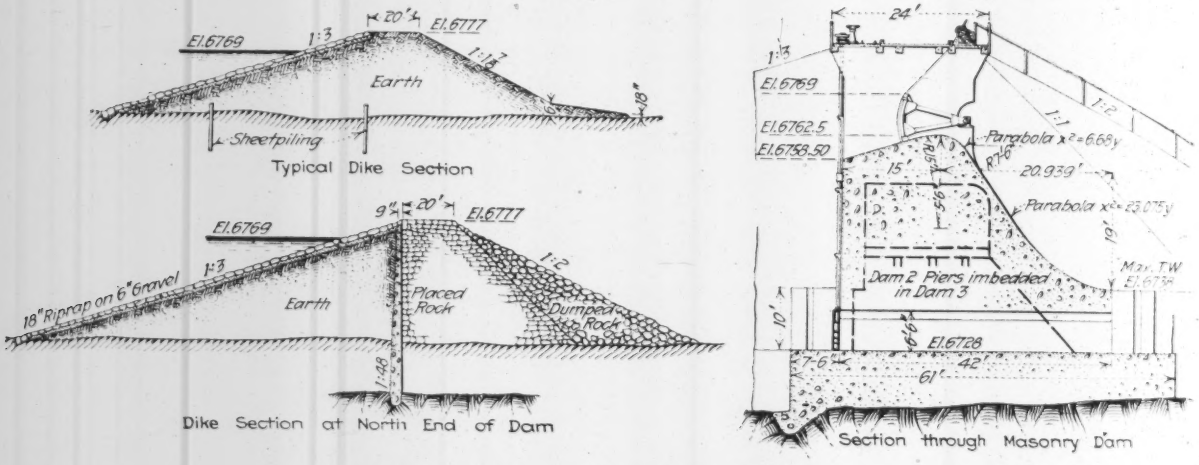
13. That the present system of student prizes be continued and, if found possible and advisable, extended.

Jackson Lake Dam the Savior of the Snake River Valley

Third Dam in Ten Years Envelops Second — Flush Method of Delivery Discarded for Regulated Continuous-Flow Method

BY REASON of the bountiful supply of stored water Jackson Lake, in Jackson Hole, Wyoming, has been able to deliver to the farming district of southern Idaho, the lake is directly responsible for crops, equalling many times its original cost, in the Idaho Falls, Minidoka and Twin Falls districts. It is not a pretentious structure nor was its cost excessive, the developed 789,000 acre-feet storage water costing about $1.50 per acre-foot.

The construction of three dams of different types in 10 years, the envelopment of the second reinforced-concrete structure in the third massive gravity dam, a shift transversely of the last dam to a foundation on rising bedrock, and the operation incident to the delivery of stored water, are features noted below, because the working to the substantial final construction and the operation are typical experiences of many other irrigation storage properties. The following information and the photographs were obtained during an inspection of the whole Snake River Valley by a representative of *Engineering News-Record*, and also from a paper presented to the Idaho Irrigation Congress by F. A. Banks, engineer, United States Reclamation Service, with whom the inspection of the dam was made.



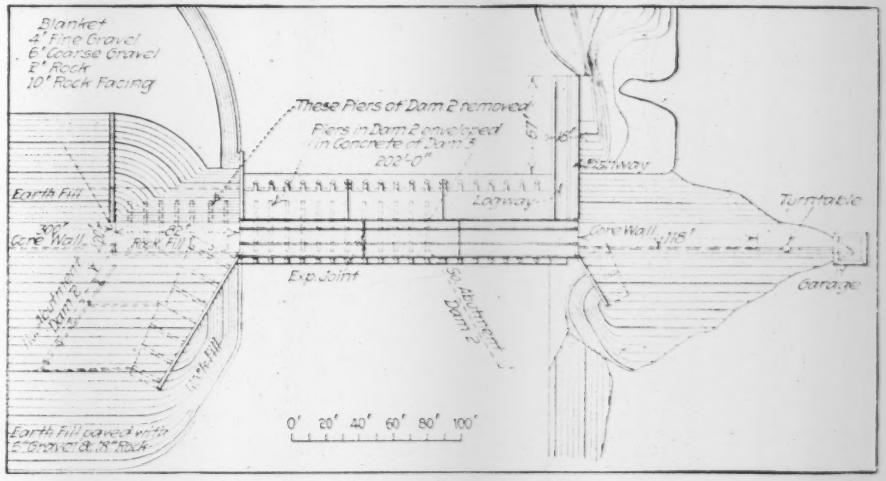
THIRD JACKSON LAKE DAM ENVELOPS DAM 2

Of the three dams constructed across the outlet of Jackson Lake, through which the south branch of the Snake River runs, all were for the purpose of storing additional water for irrigation over and above the natural run-off, the latter being appropriated thirty to forty years ago by early settlers.

The first storage development was a temporary timber crib dam built by the United States Reclamation Service in 1906-7, the first water being stored in 1908. It was the intention to utilize it later as a cofferdam for a permanent dam. The water was raised 14 ft., providing for 250,000 acre-feet storage on top of the original surface, which covered 17,500 acres. On July 5, 1910, nine of the 30 cribs were washed out, and immediately work was started on dam 2, a 206-ft. reinforced-concrete gate section composed of piers 2 ft. thick on 10-ft. centers separated by decks and a curtain wall. For 50 ft. at the north end the dam was founded on piles driven to rock. The remainder rested on rock. A rock-filled crib took the place of a concrete floor in the north half of the dam. Twenty 5 x 8-ft. radial gates controlled the discharge openings at the bottom of the curtain wall between the piers. Flashboards above a platform or deck at an elevation 17 ft. above the gate sills raised the leak level another 7 ft. A concrete core wall founded on rock was constructed for the entire 200 ft. length of the south dike, and another, founded on sheet-piles, was run 300 ft. into the 2600-ft. north dike. Shortly after the completion of the dam in 1911, an agreement was entered into between the Reclamation Service and the Twin Falls Canal Co. and the Kuhn Irrigation & Canal Co., representing respectively the Twin Falls south and north side projects, to raise the height of the dam an additional 17 ft., thereby increasing the storage from 380,000 acre-feet to 789,000 acre-feet. Costs were borne by the companies, and the work was completed by force account by the Reclamation Service in 1916.

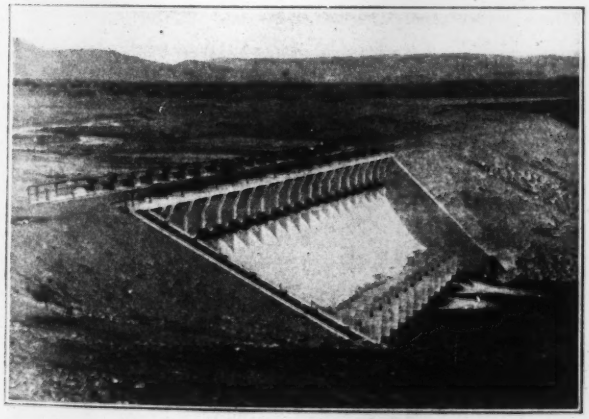
Dam 3, enveloping No. 2, has a concrete gravity section 222 ft. long containing twenty 6 x 8-ft. outlet tunnels controlled by sliding sluice gates, 19 radial spillway gates 6½ ft. high and 8 ft. long, one logway equipped with a radial spillway gate and a fish ladder. The radial gates were salvaged from dam 2. The sluice gates are operated by Ford automobile engines installed on homemade trucks running the length of the dam over an industrial track. The structure was moved transversely to the south 82 ft., since bedrock under the north end of the dam dipped rapidly below the river bed and it was desired to found all of this third dam on rock. Concrete core walls were sunk to bedrock and extended into the north dike to join the core walls already built extending 300 ft. beyond the end of dam 2. The 4000-ft. north dike is riprapped with stone 18 in. thick laid on 6 in. of gravel. The earth embankment was placed by a hydraulic dredge located in the reservoir site, leaving a 200-ft. berm between the borrow pit

and the dike. About 2½-sec.ft. leakage develops when the reservoir is filled, but the seepage water is always clear and shows no tendency to increase in volume; therefore no apprehension of damage is felt. When the reservoir was filled, some seepage developed at the lower toe. To reduce seepage through the dike, a layer of borrow-pit run of gravel-bearing clay was placed on the upstream face, and to suppress the springs formed by seepage under the dike the downstream slope was changed from 2 : 1 to 1¾ : 1, and the material obtained was used to form a blanket. To prevent logs which are uprooted by the heavy ice on the flooded wooded area from interfering with the spillway and clogging the gates, a log boom has been thrown in front of the dam. Logs are towed by a small launch to the dike, and in the summer when the lake is emptied they are piled and burned. The normal area of the water surface was increased from 17,000 to 25,000 acres. Much of the flooded area has now been cleared by the ice action, the logs floating to the nearby shores, where many of them indicate that rapid decay has already started.



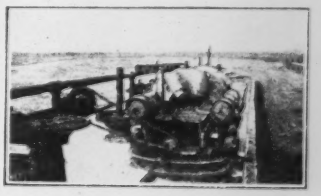
SECTION OF JACKSON LAKE DAM

The Jackson Lake watershed is 820 square miles of mountainous country ranging from 6700 to 14,000 ft. above sea level, from which the main run-off, particularly that which can be stored—as distinguished from natural flow which is needed for immediate irrigation—is melted snow. The mean annual run-off is 1,000,000 acre-ft., and the storage has been developed to a point where, with the present heavy irrigation demands, even with holdover added, the reservoir will fill on an average of but seven out of eight years. During 1918-1919 only 558,000 acre-ft. were stored, hence scientific operation to conserve all of the stored water becomes extremely necessary. The water thus stored supplements the water rights of 750,000 acres of land bearing crops which are worth much in excess of $30,000,000 annually. Specifically, water may be stored when any water is wasted over the Milner dam, which is the last large diversion point on the river. Also, when the flow falls below 10,000 sec.-ft. at the Heise gaging station, located above all of the diversions, the gates must be opened and the natural flow released to supply prior interests.



MASSIVE MASONRY SECTION HAS RADIAL SPILLWAY GATES—LONG DIKE IS RIPRAPPED BOTH SIDES

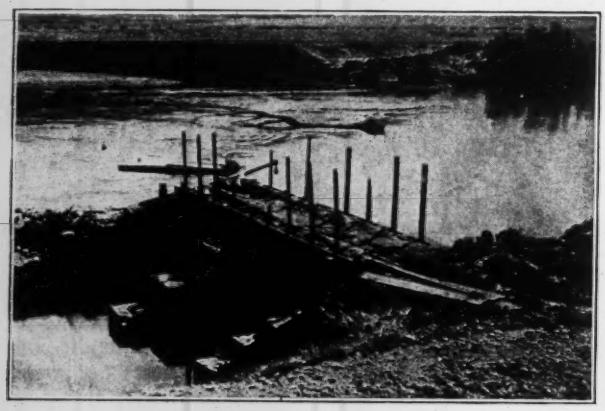
The two systems employed in the delivery of stored water are, first, the release of large heads in separate flushes, and, second, the maintenance of a uniform flow to meet the demands. With the first method, which was used from 1908 to 1911, the natural flow was established, and then an attempt was made to limit these diversions to the natural flow while the stored water was flushed by the Upper Valley headgates to the Lower Valley. Computing the time when Lake Walcott, the Reclamation Service distributing reservoir for the Minidoka project, would be empty, a head large enough to fill it would be released from Jackson Lake in time to cover any shortage. The lake gates were shut off before wasting at Walcott occurred. Previous to the flush, all of the Upper Valley gates were staked, and after the water had passed they were restaked, based on resumed natural flows. The arrangement was unsatisfactory to all interests. When the canals were staked under a falling river the stored water interests lost much water. The heavy flushes washed out the temporary wing dams which the Upper Valley water users had to reconstruct as the natural flow decreased. The expense of reconstruction and the interruption incident to their repair or replacement led to the second method, which has been in operation since 1911.



CHAIN CONNECTS FORD MOTOR ON INDUSTRIAL CAR WITH GATE STAND

Assumptions are made as to the loss of stored water between various gaging points in the upper stretches; these assumptions are based on past experience. The return flows are also accounted for, and by a process of additions and subtractions the stored-water and natural-water proportions are determined at every gaging and large diversion point in the river. A deputy state engineer handles the stored water, and a water

master the natural flow. This season all of the numerous interests combined to obtain a well paid engineering organization which would collect data to regulate the flow to meet the demands and priorities daily. To the deputy are reported daily, by telephone, gagings by hydrographers from the various stations on the river, together with information concerning all diversions, by ditch riders, and of the stages of Jackson Lake and of various smaller storage reservoirs. These men are all



ANDERSON DIVERSION DAM BELOW HEISE GAGING STATION WASHED OUT

under one general supervision, the water master working in close harmony with the deputy. Reports and calculations are completed daily, and one day's orders for operations are based on those of the day previous.

The Jackson Lake dam was designed by F. A. Banks, engineer, and constructed under the direct supervision of Mr. Banks and F. T. Crowe, superintendent of construction, reporting to F. E. Weymouth, then supervising engineer, Jackson Lake Enlargment Project. Its operation is now under the general direction of Barry Dibble, project manager, Minidoka project. G. Clyde Baldwin is the special deputy for the state engineer controlling the transit of the stored water past 50 headgates, 315 miles from Moran to the last diversion at Lake Walcott and Milner. John Empey is water master in charge of the natural flow. The office of water master is elective.

Durability of Green and Seasoned Timber

Durability of untreated timber exposed to the weather and in contact with the ground is about the same for green and seasoned timber, according to experiments made by the United States Forest Products Laboratory. Ties of green larch on the Northern Pacific R.R. had an average life of 7.3 years, while Douglas fir had an average of 7.6 years in Montana and 7.7 years in Washington. For seasoned ties the averages were 7.4, 7.7 and 7.8 years, respectively, the difference being so slight as to be negligible. Observations on telegraph and telephone poles showed a slightly lower rate of decay for green than for seasoned timber. This condition is due to the fact that the moisture content is the principal factor in determining the rate of decay, and that both green and seasoned timbers, when exposed, soon reach the same moisture content. Wood for interior construction in buildings, however, usually does not dry out rapidly and must be seasoned before use; otherwise it is likely to shrink and decay.

Through Concrete Arch Bridge to Give Large Waterway

Roadway Suspended by Light Hangers and Each Floor-Beam Hinged to Allow Bending Under Arch Expansion

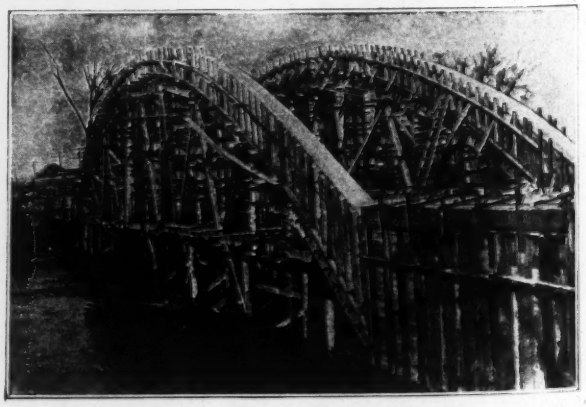
By F. W. Epps
Bridge Engineer, Kansas Highway Commission, Topeka, Kansas

IN replacing a through steel truss bridge across Soldier Creek, at Kansas City, Mo., a somewhat uncommon through concrete arch bridge was recently built, with a resulting economy, pleasing appearance and large waterway, all necessities of the design.

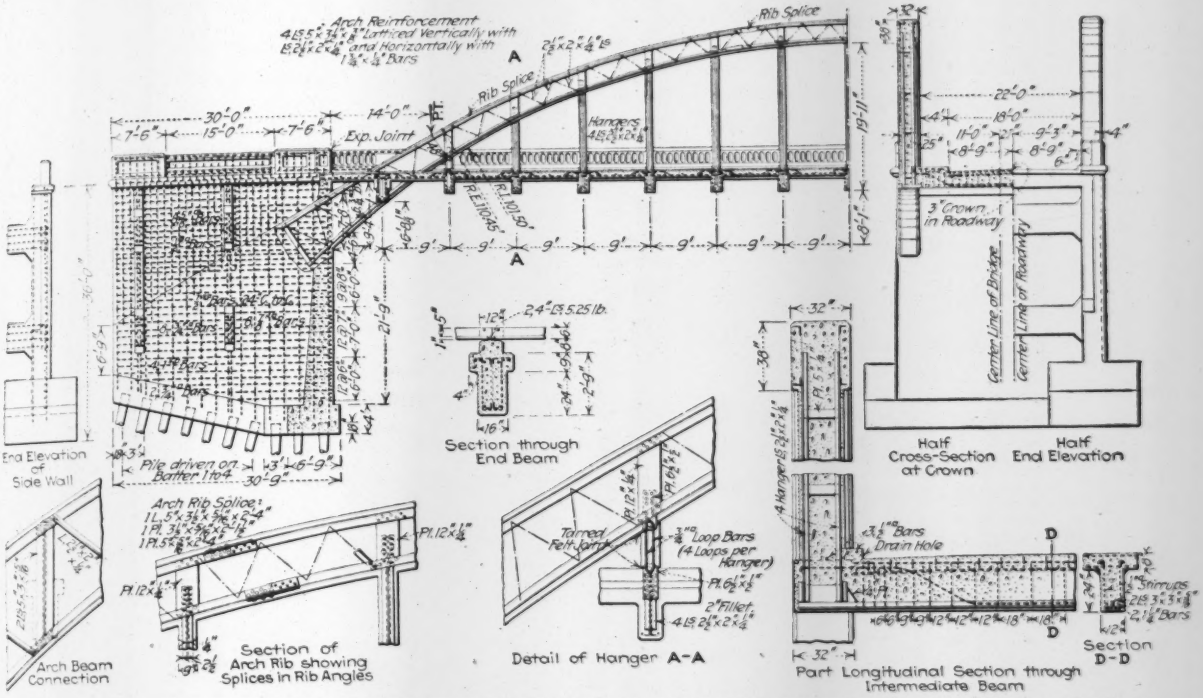
The old bridge, a 130 ft. span of light construction, carried a heavy traffic into the city and was found to be unsafe. The clear waterway of this span was 2300 sq.ft., but this was found to be too small in time of flood so the drainage board established the enlarged area at 3000 sq.ft. The conditions to be met in designing the

COMPLETED SUSPENDED ROADWAY ARCH BRIDGE

new structure were four in number: First, there had to be an enlarged waterway; second, grades on both sides of the bridge were fixed by adjacent property; third, it was desirable to have a beautiful structure on account of its location at the edge of the city with a park on one bank of the stream; and, fourth, economy was demanded. A through steel truss bridge would have met the first and second conditions, but would have been of prohibitive cost because of the war price of steel. A spandrel arch, in order to meet the waterway requirements, would have made necessary a change in grade



ARCH RIBS SUPPORTED ON FALSEWORK



DETAILS OF REINFORCED-CONCRETE BRIDGE, SUSPENDED ROADWAY, SOLDIER CREEK, TOPEKA, KANSAS

or a longer span, thereby increasing the cost. The length of span used, 140 ft. was determined by the required waterway and the existing banks of the stream. The reinforced-concrete twin arches with suspended roadway answered all requirements of clearance, cost and strength.

The two arch ribs were designed as simple arches, reinforced with four 5 x 3½ x ⅜ in. angles laced together with plates and angles, and carrying the angles of the hangers by a riveted connection. This reinforcing steel was not intended to carry the erection loads. The hangers at each floor-beam were made slender to allow bending under the deflection and expansion of the arch. As the hangers became shorter near the haunches of the arch, the stress due to this bending increased, so at the second panel from the end a pin connection was used at the arch and at the floor-beam.

As shown in the special detail, at the first floor-beam there is no hanger, the beam framing into the arch, and an expansion joint is provided between the floor-beam, which acts with the arch, and the floor slab which moves between the abutment and the pin at the first hanger.

The floor-beams were designed as T-beams, monolithic with the floor slabs. The bottom steel is of two angles framing into the hanger angles, but the stirrups and upper steel are rods. The first floor-beam, as previously stated, was made larger and separate from the floor, to act as a simple beam, and is reinforced with latticed angles. Additional stiffeners in the way of angles are placed in the arch rib at the connection of the floor-beam.

The abutments, as shown, are hollow with reinforced walls and solid extensions carrying the arches down to the footings which on the north side rest on a rock ledge, and on the south side on eighty-eight 25 ft. piles.

The entire structure was supported on falsework, the pile bents being placed 18 ft. centers under alternate panel points with a wood truss to support the intermediate panel point. During a heavy storm, high water took out one span of the falsework and threatened the entire bridge. One arch had been completed but pouring on the other arch had been finished only three days previously. There was no apparent deflection of the arch, indicating that the bridge would have stood had the falsework been entirely carried away.

In pouring concrete the abutments were carried up to the haunches of the arches, then the floor-beams were

STEEL FRAME BEFORE CONCRETE WAS POURED

poured. Next each arch was carried up from both sides at the same time, the hangers being poured as they were reached. The floor slabs were then run in, and the side walls of the abutments poured, completing the structure.

The work was under the direct supervision of J. E. Williams, County Engineer of Shawnee County. The design and plans were made by the Marsh Engineering Co., of Des Moines, Iowa, and approved by W. S. Gearhart, former State Highway Engineer. The contract was held by the Leavenworth Bridge Co., of Leavenworth, Kansas.

Electric Mucking Machine Used on Hetch Hetchy Tunnels

San Francisco Finds Equipment Developed for Mining Operations Economical for Day-Labor Tunnel Job

ON THE Hetch Hetchy water-supply project being built by San Francisco, the city is now working six headings on an 18-mile tunnel which will be entirely through solid rock. Progress on the tunnel is the limiting factor in completing the first unit of the project, and within the limits of funds available every effort is being made to advance the headings as rapidly as possible.

The contractors' bids on this tunnel work, submitted Aug. 22, 1917, were so much higher than the city engineer's estimate that all bids were rejected, and the city has been doing the work on a day-labor basis.

The longest stretch between headings is the 4.5 miles between South Fork and Early intake. On this part of the work an advance of 2500 ft. had been made on the South Fork end and 2600 ft. on the Early intake end by Nov. 1, 1919, leaving 18,600 ft. remaining to be driven. In addition to a 600-ft. shaft sunk to tunnel grade at Big Creek, a total of about 8700 ft. of driving had been made on all six headings up to Nov. 1. Progress has been slow because of delay in selling bonds. The city engineer has repeatedly pointed out that the work could be done more economically if three shifts, instead of one, could be employed.

A few months ago, in an effort to get out the muck more speedily as well as to do away with the need for employing muckers, it was decided to try an electric mucking machine, made by the Myers-Whaley Co. for handling ore in mines. The machine has been working at Priest portal, and during August the labor cost at this heading was $15, as against $23.71 and $21.42, per foot at South Fork and Early intake headings, respectively, where harder rock was encountered and hand mucking methods were used.

The machine has not been operated without interruptions. Delays have been caused by the wearing and breaking of the conveyor belt which carries the muck and by similar trouble in the chain carrying this belt. The exposure to abrasion and the rough usage incidental to continuously handling heavy broken rock is such that delay for repairs was expected at more or less frequent intervals. However, on the whole the machine has shown a material saving, the city engineer says, and additional machines for handling muck are to be put in at other headings.

In using this machine, one operator is required for manipulating the controls and another for changing cars under the delivery and of the belt conveyor. The muck is picked up from steel plates, placed before the blast, by a scoop or shovel which dumps by tilting backward. A belt conveyor takes the muck up over the top of the machine and to the rear end, where it drops into the cars placed to receive it. The shovel consists of two parts, the forward section or lip resembling the teeth of a steam-shovel bucket, and another part immediately back of the lip which serves as a scoop to receive the muck and deliver it, by tilting backward, onto the belt conveyor. In the type in use on the Hetch Hetchy the bucket will load one ton per minute under favorable conditions.

The shoveling and dumping cycle is repeated normally 10 to 15 times per minute. It has been found necessary to break up rock under 2 ft. in size, although with pieces of this maximum size the wear and tear on the machine is much greater. The belt conveyors, made of very heavy canvas, are armored with steel bars riveted through the fabric. Manganese-steel teeth are used in the shovel lip.

The entire machine can be moved forward to follow up the pile independently of the operation of shovel and belt conveyors, and the entire forward end of the machine is pivoted to be swung horizontally through an angle of 45°. Similarly, the rear conveyor has a swing of 40°, so that cars may be loaded on either track if the tunnel is served by a double-track line.

A single electric motor is used for moving the machine and operating its mechanism. Between the motor and the bucket a friction clutch is provided, set for the maximum safe motor torque, so that in case too great a load is put on the mechanism the clutch will slip and protect the motor. Motive power is provided by chain drive from the motor to all four wheels.

The work on the Hetch Hetchy project is under the supervision of M. M. O'Shaughnessy, city engineer of San Francisco.

Impressions Here and There

Public-Works Engineering in Cleveland

VARIOUS big engineering projects are afoot in Cleveland, involving questions which as yet are largely unsettled but whose final adjustment ought to come soon. In any case, a decision on these matters is bound to exert very direct influence on the city's future development. The existing situation would be of interest at any time, but seemed specially interesting during the recent pre-election doings. The campaign brought out strikingly what doubtless every engineer knows but at ordinary times does not always consciously realize: that there is only the loosest and most inefficient sort of connection between the political mechanism of city government and planning for the improvement and growth of the city.

Four mayoralty candidates have been contending for votes. One might expect that such a campaign would be very educational, that the larger matters affecting the city's future would be fully discussed, and that in this way the election would be a step in municipal progress. Nothing of the kind developed. The actual issues were the usual commonplaces. There was nothing that would lift the election above the plane of ordinary political contention, nothing that would warrant a hope that the public will take its future into its own hands by insisting that the planning for all controlling features of city development be done by the municipal engineers.

The background behind the persons and parties of the campaign is made up of half a dozen public-works projects of great magnitude, of determining effect on the city's future but themselves quite out of the city's control, apparently. The latter fact may explain in

part why the recent campaign did not concern itself with them. In so far as such enterprises require a city franchise or city money, they are (under the Cleveland system) voted on in special referendum elections, which, however, naturally take on a political aspect themselves and do not necessarily produce technically sound decisions.

Of the present projects some are in the hands of the county (city and county government being still separate in Cleveland), some in the hands of a newly created political body, and some in charge of private interests. Broadly speaking, the city, though possessing a good, if uncentralized, engineering organization with a number of strong men in it, stands by as a passive onlooker while various outside bodies plan out its future development. The newly formed conservancy district for river straightening is organized under a state flood protection law passed five years ago, and will work out its plans and raise money without reference to people or city council. The costly Lorain-Huron bridge is to be built by the county, though it will be in every sense a city thoroughfare. The Union Station enterprise, approved in general terms last winter by popular vote in favor of a franchise ordinance, is now wholly a matter of negotiation between private corporations, and its details will be worked out by them. In each instance, the city's engineers will have to govern their own work by that of the outside bodies, and must adjust public services and reshape traffic currents not according to the city's needs but according to the preferences of men devoted to other interests. Would it not appear possible to get more consistent and more efficient results through some centralization of function and responsibility where it really belongs, in the city's engineering department?

Some delay in public-works planning resulted from the election in at least one case. The effect is the more unfortunate because the past season has not been active either in public improvement or in maintenance work. The street-car-subway scheme proposed last summer has been allowed to sleep for several months, so that it would not be dragged into the campaign, it is said. With the election over it is certain to be put to popular vote soon. Even now, however, final action on may be premature, as it does not appear that the value of the scheme to the city's welfare and future development has been studied from the standpoint of the city's own engineers, who, of course, are primarily concerned with planning along these lines.

River Straightening

Newest among the large-scale improvement projects the Conservancy District has not yet passed through the teething stage. Recently the county court approved the formation of the district, limiting it to that part of the Cuyahoga River valley lying in Cuyahoga County (thus not even including all of the city), and subsequently appointing three directors—business men and lawyers, not a single engineer. But the court's action has been appealed, and the case is likely to be interesting. Though the district was formed under the flood-protection law, the case might be described as a project for straightening the Cuyahoga with flood protection as its most convenient justification, rather than a project for flood protection with river straightening as its most convenient method. It is admitted that the straightening will be greatly beneficial to navigation in the river, and many people suspect that the flood-reducing effect is likely to be exceedingly small. This curious phase of the matter, however, leads to another difficulty.

As the lower Cuyahoga valley is filled brimful of factories, railroad yards and docks, any sort of channel rectification is going to mean a pretty thorough tearing up. Just at present no one knows what can be done, what needs to be done, and what it would be profitable to do, in the way of river improvement through the bottoms. In any event the cost and damages will be very great, and under the law they must be assessed where the benefits will lie. Taking account of the increased harbor values created along the straightened river, the principal gains, it is generally conceded, will go to industrial plants up the valley, which will be able to bring lake ore to their docks more cheaply. To what extent these various interests will submit to navigation-benefit assessments, and to what extent flood-protection benefits will cover the cost of the work, cannot be foretold. It is going to be hard enough to work out any sort of river improvement that will be defensible in court as a sound engineering project; but benefit assessment is going to be a still harder task. Builders of river-straightening machinery need not look for inquiries from the Cuyahoga Conservancy District within the next year or so.

It is also an interesting fact to note that the restoration of the river as a harbor is in conflict with the half-evolved lakefront harbor project, which, however, seems to have been dormant of late.

Rapid Transit and the Public Square Problem.

Three other projects closely interdependent form a problem many times larger than this and one in which it would seem that by all means the municipal engineers should have a controlling voice. These are the new union station in the Public Square, the plan for suburban or semi-rapid-transit service on the C. & Y. (Cleveland & Youngstown R. R.,) and the downtown terminal loop subway for street cars. The C. & Y., by the way, is expected to start suburban service in a small way very soon, operated by the Cleveland Railways Co.; a dozen or so cars are now being refitted for the proposed service.

So far as rapid transit is concerned, it is rumored that those on the inside have held that the city does not need and should not build rapid transit lines of its own, but that private enterprise either by means of a subway system through the streets or preferably by utilizing the C. & Y. right-of-way should furnish the service. This sort of planning, however, was largely that of private parties, and to some extent of public political officials, but not of the city engineers; the latter apparently have not been asked or had opportunity to study rapid transit.

As to the C. & Y. project, which was originally a suburban railway scheme to develop a section of outlying real estate, it grew larger when the Nickel Plate, a New York Central line, became identified with it, and soon developed into a plan for a union station to accommodate the four minor railways entering the city. This would have left the Big Four, the Penn-

sylvania, and the New York Central (the old Lake Shore) in a separate union station at the lake front. Even this arrangement would have made the crowded public square the focal point for street car and interurban traffic plus the traffic of four railways—an ideal arrangement for a city of 100,000, but hardly suited to the self-conscious 1,000,000 city. Last summer, however, the promoters brought the three big railways into the same public square plan and the scheme swelled to such an inflated cost figure as to be really startling. At that time also the Board of Rapid Transit Commissioners had under consideration a plan for "rapid transit" which was opposed to real rapid transit as being too costly but contemplated the construction of terminal-loop subways for the street cars under the square, a proposal dovetailing neatly into the C. & Y. union station scheme.

Two new cross currents in this whirlpool of projects are of some interest. Experts have recently testified that within a very few years the city will need extensive rapid-transit service and will need to spend great sums of money in providing it. On the other hand, opinion among city officials seems to be shifting away from the plan to build short terminal-loop subways (which would cost $15,000,000 but would not earn a cent) and to favor building instead a couple of miles of subway capable of giving real rapid transit service. This may develop further within a short time.

The thing that stands out is that the whole case or group of cases is far more important to the city than to any one of the private interests involved and that yet the principal decisions are reached by the bankers and representatives of private interests, and not by those men who, through technical knowledge and through conscientious disinterested responsibility are specially fitted to plan for the city's development.

Miscellaneous Matters

It is obvious that much repaving needs to be done in Cleveland. But the city's financial condition may interfere here, or at least make progress slow. Another opportunity for a careful engineering look ahead.

Salary scheduling for engineers in the municipal employ is an active subject at the moment. A committee has worked out a classification and submitted it to the Board of Control for approval. Its strongest feature is said to be this: That a definite starting point of the schedule was established by equating the lower grades (engineering aid and apprentice, such as levelman, rodman and plain draftsman) to the grade of mechanic and mechanic's helper. This fixes for the lower engineering grades a far juster compensation than is now generally paid and allows of stepping up in consistent relation to the grades of higher experience and responsibility.

These same engineering employees who have been trying to deal systematically with the pay question did the unusual by holding a political meeting during the campaign now over. It was a very live meeting at that. Their organizaion, the local chapter of the A. A. E., invited all four mayoralty candidates to address them at a special meeting—and the best part of it is that all four were present, either in person or by representative. Says one of the organizers, "We wanted to get the boys interested in city government. And, in the second place, we wanted to show those politicians that engineers are a factor to be reckoned with in future political calculations."

If the Cleveland engineers keep this up they may yet get to the point of securing representation on boards and commissions appointed to handle technical subjects.

Nov. 8, 1919. CLEVELAND.

Sand Removed From Canal by Sluicing

REMOVAL of sand blown into the west extension main canal of the Umatilla irrigation project, United States Reclamation Service, has been a source of trouble since the canal was put in operation in 1916. This canal is 26¾ miles in length, is lined with concrete and has a designed capacity of 365 sec.-ft. at the head to 77.5 sec.-ft. at the lower end. It passes through sandy areas subject to high winds, and in 1916 and 1917 it was nearly filled at some places by the drifting sand. Channels in this were cut by teams and scrapers. In 1918 a 12-mile stretch contained some 50,000 to 75,000 cu.yd., but the canal could not be cleaned by teams unless the water were turned out. To avoid this, sluiceways were proposed, and four such structures were built, but with the 30-sec.-ft. available the sand was moved for only about ¼ mile. Loosening by teams, and other methods, were not successful, as the sand was too heavy to remain in suspension and would soon settle again.

The problem of transporting the blown sand with a comparatively small head of water was solved by the use of a gate or templet to check the water and concentrate its flow around the bottom and sides. Experiments lead to the development of a wooden diaphragm about 6 in. smaller than the section of the canal, supported by a 4 x 6-in. timber laid across the canal. At the middle is a 2-ft. opening from top to bottom which permits the escaping water to act on the middle of the sand bed as well as at the sides and bottom. As the water washed the sand away the templet was shifted a few feet downstream. The water pressure assisted this movement materially, so that one man could operate the device easily by crossing back and forth on the timber.

With a cost of 15.8c. per cubic yard for the field work, 5.9c. for engineering superintendence and overhead charges, and 4c. as a plant charge for building sluiceways, the total cost was 25.7c. per cubic yard. With teams and scraper the cost was 27c. to 40c. in removing the top portion of the sand, and it would have been much higher for a greater depth of excavation.

To prevent the wind from blowing the sand, the spoil banks have been covered with brush and sand fences of brush built at right angles to the canal where some of the worst blows occurred. Rye was sown on the banks, but there was not sufficient moisture for its growth, while the loose sand is not conducive to the growth of weeds or grass. It is thought that the canal can be kept clean by the protection work on the banks and by running water to the limit of the capacity of the canal.

The above information is from an article by H. M. Schilling, project manager, in the September issue of the *Reclamation Record*, published by the United States Reclamation Service.

Small River Terminal For Widely Varying Water Stages

Municipal Pier and Warehouse on Cape Fear River at Fayetteville, N. C., Solves Problem of Local Freight Handling

By Hunley Abbott

General Manager, Alsop & Peirce, Contracting Engineers, Newport News, Va.

FREIGHT handling from ship to shore on rivers of widely varying stages is always a difficult matter. How the pier was designed for one small river terminal is shown in the accompanying drawing of the municipal pier and warehouse to be built for the City of Fayetteville, N. C., on the Cape Fear River. The United States Government is spending more than $1,000,000 to dredge an 8-ft. channel in the Cape Fear River from Fayetteville to Wilmington, a distance of about 110 miles, and the city intends to provide easy access to the river boats for both railway and team deliveries.

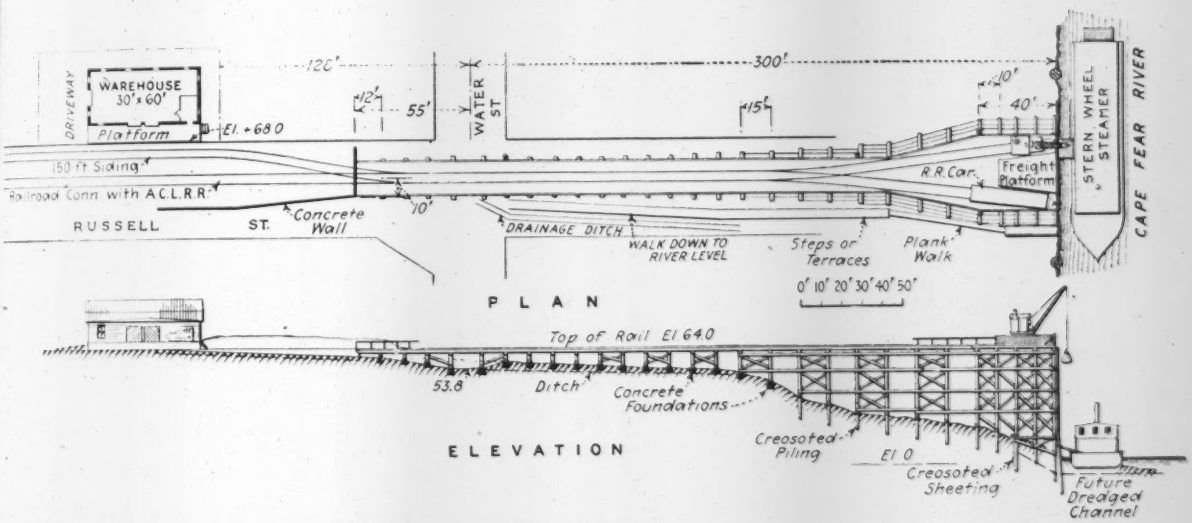
The banks of the river at Fayetteville are very steep and high, and great variations often occur in the water stages. The river has been known to rise 68 ft. above low-water level, and a rise of 30 to 40 ft. is to be expected several times each year.

The chief problems to solve in the design of this warehouse and pier were: (1) The warehouse was to be located well above the highest water stages of the river; (2) the pier was to be so designed that traffic could be handled over it at practically all stages of water; (3) it was to be located at the most convenient and economic point and was to have a railroad connection as well as team facilities; (4) it was to be designed to handle practically any and all kinds of goods, package goods, cotton, lumber, piling and material in bulk, such as coal, sand, gravel, acid phosphate and the like; (5) economic freight-handling equipment was to be installed; (6) the total cost of these improvements was not to exceed $75,000.

These conditions were met by locating the warehouse on high ground near the foot of Russell St., with floor at El. 68, and running a timber trestle from that point out to the river bank, as shown on accompanying drawing.

A connection with the main line of the Atlantic Coast Line R.R. is brought down Russell St and carried out to the end of the pier, with a siding in front of the warehouse. The top of the rail and the deck of pier are kept 4 ft. below the elevation of the warehouse floor, to facilitate loading to and from warehouse by team or railroad car.

The pier is widened out at the river end, and the railroad track is split into a Y, with a raised freight platform in between. Railroad cars and teams are brought out on the pier, and unload onto the pier-head platform. A locomotive crane standing on one of the branches of the Y transfers freight to and from river steamers lying at the head of the pier. Net slings will be used for package goods, and a clamshell bucket may be used for material in bulk.



GENERAL PLAN OF MUNICIPAL PIER AND WAREHOUSE ON THE CAPE FEAR RIVER AT FAYETTEVILLE, N. C.

After careful study, the locomotive crane was chosen as the most desirable piece of equipment, because it could not only handle freight to and from boats but could be used to switch cars on and off the pier. A freight elevator was considered for this work, but was abandoned because it was not adapted to the economic handling of bulk material, such as coal, sand, etc., nor very long pieces, such as piling and lumber; also because additional equipment would have had to be provided for shifting railroad cars on and off the pier.

Another feature of interest is the foundation construction for the outshore bents. Creosoted piles are used to prevent decay, and the bents are secured to the piles by steel strops to prevent flotation and overturning during flood stages.

A small hand-operated flat-car running on the railroad track is provided for transferring goods from warehouse to pier head, or vice versa, but it is expected that only a small percentage of the freight will be handled in this way.

It is expected that about 50,000 tons of freight per annum will be handled over this pier.

This work was designed by Alsop & Peirce of Newport News, Va., the writer being in charge and assisted by E. G. Carey.

Britain Suggests "Team Spirit" Plan for Building Trades

Fair Wage for Worker; Salary for Owner-Manager, and Fixed Income for Hire of Capital, Main Remedial Principles

DEVELOPMENT of the "team spirit" in industry, considered the key to the problem of production, is urged in the interim report of the Committee on Scientific Management and Reduction of Costs, appointed by the Industrial Council of the Building Trades Parliament of Great Britain. The report, after submission to the chairman of the Industrial Council for the building industry, has been referred back to the committee submitting it, for further consideration and elaboration.

This committee, equally divided between employers and employees in the building trades, came to the early conclusion that the great task lying before the Industrial Council was the development of an entirely new system of industrial control by members of the industry itself—actual producers, whether hand or brain—and to bring such members of the industry into coöperation with the state as the central representative of the community which they are organized to serve.

Further investigation by the committee led it to see the possibility of the whole building industry of Great Britain being welded into one great self-governing democracy of organized public service—uniting a full measure of free initiative and enterprise with all the best that applied science and research can render.

The committee found that the whole conception of organized public service demanded the acceptance of three main principles as an essential to that increase of efficiency without which the cost to the community could not be reduced:

1. Regular rates of pay to the operators that insure a real and satisfactory standard of comfort.
2. Salaries to owner-managers commensurate with their ability.
3. A regular rate of interest for the hire of capital.

Upon the acceptance of these three principles, the report states, depends the rapidity with which the "team spirit" in industry develops.

The committee found at the outset that four main factors militated against efficient production. These were fear of unemployment; the disinclination of the operatives to make unrestricted profits for private employers; lack of interest on the part of the workers in the industry owing to lack of participation in control; and inefficiency, both managerial and operative.

In order to remove the fear of unemployment it was suggested that the whole productive capacity of the industry should be continuously engaged and absorbed, and that a regular flow of contracts should replace the old haphazard order of congestion and stagnation. To engage industry continuously it was recommended that the Industrial Council set up a permanent committee called the Building Trades Central Employment Committee with regional councils and local or area councils, each committee to consist of an equal number of employers and operatives supplemented by one architect. The prime function of these committees would be to accelerate new building enterprises, both public and private,, through the coöperation of architects and local authorities, and conversely during periods of congestion to advise building owners to postpone [illegible] such works as were not of urgent [illegible]

The second main function of the [illegible] committee would be the decasualization [illegible] seasonal interchange of it. Afforestation, [illegible] the preparation of sites for housing [illegible] demolition of unsanitary or condemned [illegible] tion for improvements, were cited as [illegible] the laborer could be employed when the [illegible] could not support him. Cases of unavoidable unemployment would be maintained through a tax upon wages.

One of the salient features of the entire committee report was the fact that trade unions in general repudiated any scheme admitting operatives to copartnership, or any plan favoring profit sharing. All such methods of payment are strictly forbidden in the rules of most trade unions in the industry. The fear of disintegrating influences being introduced among the workers through the operation of any such system, and the difficulty of applying most methods of payment by results to the peculiar conditions of the building industry, were prime reasons why any scheme of profit sharing is generally condemned by British trade unions. It was found, however, that unions involved were ready to reconsider their attitude if the surplus earnings of the industry went not to individuals but to some common service controlled by the industry as a whole. This aspect of the situation brought the committee to a consideration of the wages of management.

In the case of owner-managers it was deemed rather difficult to put upon management a proper financial appraisal. A final suggestion was made that each employer-manager declare what salary he receives or what he regards as his due, and a review be made of these declarations by the employment committees in order that a recognized standard of remuneration might be developed.

Realizing that one of the many unsatisfactory features of the building industry heretofore had been the precarious nature of the employer's position and investment, it was recognized that confidence on the part of employers and operatives alike was a positive essential for efficiency. To secure that confidence and consequently the proper efficiency, the committee advised that the earnings of employers should be clearly and definitely separated under two headings—namely, the wages of management or remuneration paid by the business for personal service, and the interest or charges paid by the business for the hire of the capital. Wages of management should depend upon ability, and interest on capital upon the security and market price of money.

To secure public interest in building industries thus managed, recommendations were made that the amount of surplus earnings of the industry be publicly declared each year and that such public declarations be accompanied by a schedule of the services to which the money had been voted. It was also recommended that such surplus be held in trust by a national joint committee of the Building Trades Industrial Council and be applied to the following services which could be developed under the control of the industry as a whole: (1) Guarantee of interest on approved capital; (2) loans to firms in the industry for purposes of development; (3) education and research in various directions for improvement of the industry, both independently and in coöperation with other industries; (4) superannua-

tion schemes for the whole registered personnel of the industry; (5) replacement of approved capital lost through no fault of the management, and (6) such other purposes as may be thought desirable.

The committee also made rather lengthy recommendations as to what systems of cost and accountancy should be developed and adopted by the Building Trades Parliament. It was agreed that an accurate system of "costing" was the only foundation upon which the whole structure of scientific management could be safely erected.

Floods on the Lower Rio Grande in New Mexico and Texas

Review of Available Records and Estimates Made by Weather Bureau and Local Observers—High River Stages, 1872 to 1919

By Alfred J. Henry
Meteorologist, Washington, D. C.

From advance pages, United States "Monthly Weather Review" for October, 1919

THE great extension of irrigation works throughout the lower Rio Grande valley has made intensive agriculture possible in large portions of Starr, Hidalgo and Cameron Counties, Texas. The recent overflow of the river and the destruction of crops with very considerable damage to irrigation works has again drawn attention to the frequency of destructive floods in that part of the river basin.

The Rio Grande rises in the mountains of southwestern Colorado at an altitude of more than 10,000 ft. above sea level, flows in a general southeasterly direction for 1800 miles and empties into the Gulf of Mexico at Brownsville, Tex. From its source to El Paso, Tex., a distance of 740 miles, the fall is 8300 ft. and from El Paso to the mouth—1030 miles—the fall is 3700 ft. In that section of the river below Laredo, Tex., the fall is much smaller, and in the last 100 miles of its course is probably less than 1 ft. per mile. The banks of the river at Laredo and thence upstream to El Paso are generally high, 35-40 ft., and the river flows through a very sparsely settled region, hence the opportunity for damage by flood is very small. In the lower reaches of the stream the banks are only about half as high as at Laredo and while the normal flow is always well within its banks yet, at times, the fluctuations of flow are very great.

The only tributary of consequence on the left bank is the Pecos River of Texas. On the right bank, however, the following named streams join the main river below Presidio, Tex.: San Juan, Alamo, Salado and Conchos.

It so happens that tropical storms which strike the Gulf Coast in the vicinity of the mouth of the Rio Grande generally dissipate in torrential rains over northern Mexico. Owing to the highly diversified topography and the sparseness of the vegetal cover on most of this region the run-off is very great and practically all of it comes from the right bank. There are two flood seasons on the Rio Grande, namely, the late spring and early autumn. The first comes generally in May, when the run-off from melting snow reaches its maximum. Heavy rainfall over the watershed in southern Colorado and New Mexico is quite apt to cause floods in the river in those states notwithstanding the fact that considerable flow is diverted for irrigation. A serious flood in the lower river is rarely caused by an upstream flood unless heavy rain should fall in the lower watershed concurrently with rains in west Texas and New Mexico. The autumn flood is confined almost wholly to the lower river and may be considered as the major flood of the year. It is an aftermath of the tropical storms or West Indian hurricanes which occasionally strike the coast in the vicinity of the mouth of the Rio Grande, as above stated.

There are no bridges across the Rio Grande below Laredo and no permanent object upon which to install a river gage, hence it has been with the greatest difficulty that a river gage has been maintained for any length of time at the points where overflow takes place. Continuous gagings have been made at Rio Grande City for a period of but six years. Unofficial information gleaned mainly from press dispatches and unpublished manuscript reports from the flooded regions enables us to list the destructive floods in the lower Rio Grande (grouped as spring and autumn) in the following paragraphs:

June, 1903 Flood: A level of 19.5 ft. is said to have been reached at Roma, Tex., and a rise of 15 ft. occurred at Fort Ringgold (Rio Grande City).

May, 1905, Flood: This flood was confined to the upper reaches of the stream in New Mexico and extreme west Texas.

September-October, 1904, Flood: This flood was due to heavy rains over the watershed in New Mexico and also over the greater portion of the Rio Grande valley in Texas, especially in September. At Rio Grande City, Tex., the river overflowed its banks from September 16 to 22, resulting in the complete destruction of all crops planted along the river valley and a number of small shacks or huts.

August, 1909, Flood: This storm caused high tides on the coast of Texas and considerable damage by wind and water in the lower coast country. At Corpus Christi a wind velocity of 56 miles per hour was recorded on Aug. 27. The attending precipitation was exceptionally heavy, especially in northern Mexico, where it inundated the country, causing much loss of life and property, and much suffering. The lower Rio Grande rose higher than known for years and flooded the lowlands for miles, resulting in an interruption of traffic and communication and doing other damage. At the close of the month the river had begun to recede at Sam Fordyce, but continued at high-water mark below that place.

September, 1910, Flood: At Mission, Tex.; on Sept. 14, 5.65 in. of rain fell at Mission in 24 consecutive hours, and between Mission and Brownsville the rainfall for the corresponding period was much heavier. The river reached flood stage on the morning of Sept. 19, when it was 26 ft. 10 in. above the lowest known water that year. There being no river gage it was difficult to ascertain how this year's flood compares with that of last year, but from those who have been close observers of the river for many years, it is learned that the high-water mark of 1909 exceeded that of this year by about 4 feet.

September, 1919, Flood: This flood was due to heavy rains that fell in connection with the tropical storms of Sept. 14-16. The rise at Eagle Pass, Tex., amounted to 27.2 ft. in 24 hours, on Sept. 16. This rise was followed by a second period of rains and a second flood wave on the 22d though not so severe as the first. Below Eagle

Pass there was but a single crest, of 26.2 ft., on the Rio Grande City gage on Sept. 26. (For additional information respecting this flood see *Monthly Weather Review*, vol. 47, p. 674).

The highest stage of record at Rio Grande City, Tex., is 31.5 ft. in 1872. Details of this flood are lacking.

Following is a statement of the highest stages each year compiled from various sources for the earlier years and from the regular observations since 1914:

Year	Month	Highest Stage	Authority
1872	.....	31.5	Local reports
1892	August	20.2	U. S. Weather Bureau
1893	.....	...	No flood
1903	June	21.0	Estimated on rise at Roma just above Rio Grande
1904	October	30.0	Estimated on rise at Ft. Ringgold
1909	August	30.0	Estimated
1910	September	26.0	Estimated
1913	October	28.0	U. S. Weather Bureau
1914	October	25.5	U. S. Weather Bureau
1915	September	16.8	U. S. Weather Bureau
1916	September	20.8	U. S. Weather Bureau
1917	October	21.7	U. S. Weather Bureau
1918	May	23.5	U. S. Weather Bureau
1919	September	26.2	U. S. Weather Bureau

Essential Functions of a State Department of Health

Legislation, Surveys of Local Work, Demonstration, Research, Standards for Records, Expert Service, Conferences, Educational Work, State Aid

THAT there is too much centralization of public-health work, and that such work should for the most part be administered by local authorities, was the thesis of a paper on "Relative Functions of State and Local Health Departments," presented before the American Public Health Association late in October, 1919, by Dr. Carl E. McCombs, of the New York Bureau of Municipal Research. At the end of his paper the author summarized what he considered to be the essential functions of a state health department, substantially as follows:

The first responsibility of a state department of health is legislation, the provision of a basic law, applicable to all local units of government. The state health authority should have the power, and it should be its duty, to promote the enactment of public-health laws covering broadly all local health work, but it should not so define and detail local procedure that the local health officer does not have to think for himself. He will be a better health officer if he does think for himself, and the community will be a better community if its powers of initiative are not too greatly curtailed.

The second responsibility of the state health department in relation to the local health department is to make surveys of local health administration. Just as the United States Public Health Service sends its officers on request into local health departments to survey their activities and make constructive recommendations, so the state health department should be prepared to make expert surveys of the local health services of the state. The state should be even better able to do this than the United States Public Health Service, because it is familiar, or ought to be familiar, with local conditions, and it is familiar also with the general and special laws of the state which govern the activities of the local health departments. The survey method should be applied also by the state health authority in rural districts where no organized health service exists. The facts obtained through the survey if made known to such rural communities would go far toward providing the needed service.

The third important duty of the state is health demonstration work carried on along the same lines as the demonstration work of the United States Public Health Service and as Dr. Dowling has so effectively done in Louisiana. The importance of this work in developing that community spirit and enterprise which I have spoken of cannot be overestimated.

Research Important

Research is the next important function of the state health service and one which has been neglected in many states. By research I mean not only laboratory research, which is of prime importance, but research in child hygiene, tuberculosis, contagious diseases and all other lines of health work, for the purpose of developing facts which local health boards cannot develop except in a very limited way. The results of such research work should of course be made available to all local health departments.

The establishment of standards of record keeping and procedure is another responsibility which the state may well assume. If the standards are well devised and helpful to the local health officers, they will be quite likely to adopt them. They will be even more likely to adopt them if standard record forms are furnished them by the state. Uniformity of record keeping is a long step toward uniformity of procedure and increased efficiency of service.

The state should also be prepared to furnish special service when called upon to do so. It should be prepared to send an expert diagnostician to the local health department when one is needed. It should be prepared to furnish a sanitary engineer to advise the local health authority with respect to water-supply, sewage disposal, disposal of garbage and refuse, and other matters requiring technical engineering knowledge. It should be prepared to send an epidemiologist to investigate outbreaks of disease in local communities and assist the local authorities in controlling them.

The state should conduct an efficient laboratory service which may be freely available to local health units for diagnostic work. It should encourage the establishment of local laboratories wherever possible; furnish free or at cost sera and vaccine, which it should make in its own laboratory; devise standards of laboratory technique and procedure which may be available to local health laboratories, and finally, as already suggested, conduct special laboratory research and make the results of its work known to local health authorities.

The state health department should also be responsible for conducting periodical conferences of local health officers, at which the local health officer may be given an opportunity to hear his own voice.

Another important service which the state health department should render is that of conducting special courses for local health officers. This work has recently been undertaken by the state health department in New York and the first course conducted last spring was a success from every point of view.

Public Needs To Be Educated

Education of the public along general health lines is an essential function of the state health department. Bulletins, pamphlets, "boiler-plate" material for the press, and particularly the rural press, traveling exhibits, special lecture service where desired—all of

these activities can be carried on most successfully under state auspices.

The state health authority should be the scorekeeper for local health departments. Having established standards of service and encouraged in all possible ways the adoption of such standards, the state authority could stimulate competition between local units by presenting comparative scores. The community which found itself a tail-ender in the health race would be likely to inquire why, and, having found out why, would in all likelihood take the necessary steps to get out of its unenviable position.

Finally, the state should be able to aid local health services through supplementing local appropriations for health work, in the same way as the Federal Government makes grants to states for certain agricultural projects, and as the United States Public Health Service has recently aided the states in the venereal diseases compaign. The Ohio law also provides for subsidy of local health services by the state. Could this be done in all states the problem of raising the efficiency of local health services would be largely solved, for the state could then set the conditions upon which the allotment of funds would be made. It was this system of conditional grants of money which resulted in the establishment of Carnegie libraries from one end of the country to the other. Communities found themselves able to raise unheard-of sums of money when they found they could get an equal amount as soon as they had raised their own share. It is too much to hope that this system can be universally effective for the improvement of local health administration except by the Federal Government, and provision should be made in any bill for a national health department for conditional grants to states which the states in their turn can apportion conditionally among the local health units.

Notes on the Activated-Sludge Plants at Houston, Texas

Remarkably Clear Effluent—Cleaning Rust From Filtros Plates—Dewatering Plant—Some Operating and First-Cost Figures

HOUSTON, Tex., has the two largest activated-sludge sewage-works yet installed. The north-side plant, put in operation in May, 1917, is rated at 10,000,000 gal. a day, and the south-side plant, in operation since Aug. 10, 1918, is rated at 5,000,000 gal. There has been considerable delay in overcoming sludge-handling difficulties at the dewatering plant built for the larger plant. Iron rust from the plateholders has clogged the filtros plates at the larger plant, necessitating removal of the plates for cleaning. The following notes on these and other phases of the two plants were obtained by a member of the editorial staff of *Engineering News-Record* early in November, 1919, through the courtesy of J. C. McVea, city engineer, and G. L. Fugate, principal assistant engineer, and in charge of sewage disposal. The plants were designed by E. E. Sands, formerly city engineer of Houston, now consulting engineer, New York City. The larger installation was described in *Engineering News* of Feb. 8, 1917, p. 236.

By way of general observation it may be said that at the time these plants were visited a remarkably clear effluent was being produced. The smaller plant, however, was treating sewage at a rate of only 1,500,000 gal. a day, but only one-half of the tank capacity, and about one-fourth of the air capacity, were being used, while at the larger plant about 4,000,000 gal. of the then daily flow of 5,500,000 gal. was being treated, some of the sewage being temporarily bypassed on account of the plate-cleaning operations described further on. One-half of the tank capacity, and one-half of the air capacity were being used; the distribution of the air was bad, due to the iron rust in the filtros plates. Not the slightest odor was observed anywhere about either plant.

Removing Iron Rust From Filtros Plates

Iron rust from the cast-iron holders, carried up by the air, has so clogged the filtros plates at the north-side plant (put in operation in May, 1917), that the plates are being reset in concrete. The rust was first noticed months after the plant was put in use. Some of the plates were so badly clogged that they would pass no air. The plate clogging was supposed to be from above until early in 1919, when, on closing down a unit, some plates were taken out and broken.

The filtros plates at this plant were cemented in with sulphur. When it was decided to replace the cast-iron holders an attempt was made to burn out the sulphur with acetylene, but this caused the filtros to crumble. It was then decided to release the plates by smashing the cast-iron holders. About 10% of the plates are broken in the process but it is thought that these can be used by sealing the cracks with portland cement.

The iron rust is being removed from the plates by immersing them in hydrochloric acid, applied at a temperature of about 98° C., of which about 2 lb., costing some 3c. a pound, is required for each plate. Tests indicate that the acid will restore the air capacity of the plates from the 0.7 cu.ft. per minute, to which it had been reduced, to 6.2 cu.ft., as compared with the original rating of 7.1—all with air under 2 in. of water pressure.

In resetting the plates, the spaces in the troughs corresponding to the cast-iron holders are being filled with 1 : 1½ cement mortar, using a galvanized-iron mold for this purpose. It was estimated that the change in setting the plates would cost some $2,500, or 65c. each, all told, for removing, cleaning, pouring mortar holders and resetting the plates. The salvage on the broken cast-iron will amount to some $2,500.

New filtros plates (12 x 12 x 1½ in.) now cost about $1.75 each, against $1.25 in 1916.

It is the opinion of Mr. Fugate that there is no advantage in using a plateholder (or in other words, in having the plates removable) provided the plant is in units. Thus far, no plates have been found broken while in service.

At the south-side plant (put in operation Aug. 10, 1918) the plates were set in cast-iron holders with a 1 : 1½ cement mortar. So far as is known, there have been no joint leaks. Some rust clogging was noticed here after 8 to 10 months, but it has not yet been serious. Most of the sulphur joints at the other plants are known to have cracked after a period of use, causing leaks.

Thus far the sludge at each plant has been pumped to lagoons 11 ft. deep, from which the top water flows back to the activation tanks. No sludge has yet been removed from these lagoons.

At the larger works a sludge-dewatering plant consisting of settling tanks, sludge rams, presses, conveying and elevating machinery and a dryer is nearly ready for use. A smaller plant may be provided at the other plant, or the settled sludge may possibly be pressed, later on, and the cake taken to the dryer at the larger plant—depending upon comparative cost, to be determined after the large dewatering plant has been operated for a time.

The sludge at the larger plant will be pumped against a maximum head of 50 ft. to three 50,000-gal. elevated wood settling tanks, supported on a reinforced-concrete platform of flat-slab construction and columns about 12 ft. in length. After 3 hours of sedimentation the top liquor goes back to the activation tanks and the sludge flows by gravity to two 500-gal. ejectors. These deliver the sludge into two presses of 120 plates each built by the Simplex Ejector Co., of Chicago. The sludge cake is dropped onto a concrete incline leading to a horizontal concrete storage tank. From this tank a horizontal screw conveyor removes the cake and discharges it onto a drag conveyor having 4 x 12-in. flights. This, in turn, delivers the sludge to a second screw conveyor, at a higher elevation, which discharges the sludge into the dryer. Delays in getting the dewatering plant into use have been caused by difficulties in finding elevating machinery that would lift the cake without clogging.

The dryer is a revolving cylinder, 5 ft. in diameter and 40 ft. long, fitted with four spiral blades for propelling the cake forward and an inner tube connected so that the highest temperature comes into contact with the wet and cold material; the heat is then graduated to lower temperatures as the cake becomes drier. The dryer is being installed by the Buckeye Dryer Co., Columbus, Ohio. The dried sludge is taken by a conveyor to an 8-mesh screen, and a pulverizer to grind all material retained by the screen. The dust from the dryer is passed through a large baffled dust chamber, where it is deposited with the aid of a water spray.

Pressing Results

Indications are that 18,000 lb. of sludge of 98.25% moisture can be reduced to 80% moisture by the presses in 8 hours, including cleaning of the press. The press will reduce the moisture to an average of about 77%. The freshness of the sludge largely governs the ease of pressing. Some details of the pressing plant remain to be perfected, including the radial ribs fitted to the filter plates which have caused the filter cloths to break. It is possible that this may be overcome by using a different class of cloth from the 11-oz. duck that was used in the tests.

After 3 hours of sedimentation the sludge moisture is reduced from 99.25 to 98%. The intention is to add about 0.65 gal. of 66° Baume sulphuric acid to each 1000 gal. of the 98% sludge before pressing. This will not only make the sludge press better but will also increase the nitrogen content from 5.47% without to 6.93% with the acid.

It is now expected that the sludge from the dewatering plant will pay the cost of operation, as well as interest and depreciation on the $85,000 of construction cost. It is estimated that pressing and drying will cost $15 a ton, which should give a profit of $4 to $10 a ton, according to the market price of the sludge. This is based on ½ ton of sludge of 10% moisture per 1,000,000 gal. of sewage. If run in three shifts it is thought that the dewatering plant would handle the sludge from 10,000,000 gal. of sewage daily, but it will be some years before three shifts will be needed. It is thought at Houston that a city having 5,000,000 gal. of sewage to treat daily need not fear to put in a dewatering plant in connection with the activated-sludge process unless the local conditions are unfavorable.

COST OF ACTIVATED-SLUDGE PLANTS OF [illegible],000 AND 5,000,000 DAILY CAPACITY AT HOUSTON, TEXAS

	North Side	South Side
Excavation	$23,5[illegible]	$5,4[illegible]
General contract	194,[illegible]	57,59[illegible]
Crane	1,2[illegible]	1,12[illegible]
Motor and blowers	2,2[illegible]	2,[illegible]
150-hp. engine	7,6[illegible]	[illegible]
Sludge pump and motor	[illegible]	[illegible]
Wayne oil tanks	[illegible]	[illegible]
Fuel oil tanks	1,2[illegible]	[illegible]
Filter plates	6,1[illegible]	2,[illegible]
Water tank	[illegible]	1,[illegible]
Water pump	[illegible]	[illegible]
Well	[illegible]	1,35[illegible]
Miscellaneous	[illegible]	[illegible]
Engineering and incidentals	10,0[illegible]	7,67[illegible]
Total	$254,671	$115,[illegible]*

*Not including 15 acres of land purchased at the north-side works and 50 acres at the south-side works (the plants occupy less than 3 acres each); nor some $85,000 for the dewatering plant at the north side works (not yet in operation; no dewatering plant as yet at south side)

Operating Results

On Jan. 1, 1919, a detailed accounting plan for operating costs was installed. Indications thus far are that for the large plant, operating at an average rate of 5,500,000 gal. a day, the cost of operation per 1,000,000 gal. will be $3.80 for labor and $8.20 for power or $12 for the two. A liberal allowance for depreciation, it is thought, would be $2. These figures do not include the cost of pumping the sewage to the works.

The free air cost per 1,000,000 cu.ft. is about $5.95 for the electric-driven machine and $3.50 for the crude oil engine, but the depreciation on the latter is higher than on the former; taking current at 1c. per kw. hr. and oil at $1.50 per barrel. Including depreciation, the air cost for the two kinds of power is not very different.

There has been no expense yet for sludge disposal, except for pumping the sludge to the lagoons.

So long as there is above 1 part per 1,000,000 of nitrate in the effluent a stability of 99 is secured. The nitrates have run as high as 16 p.p.m. but that is unusual, the average being about 5 parts.

In judging the operating results the free ammonia content is very important, Mr. Fugate says. The free ammonia in the raw sewage averages about 22 p.p.m. and in the effluent 2 to 4 p.p.m., with none at all very often. With 8 p.p.m. of free ammonia the effluent would be considered below the standard. There are sharp changes in the ammonia content which have never yet been explained. The ammonia may run at 6 p.p.m. for two days, then drop to 2 or 3 parts for no apparent reason.

The removal of total suspended solids is about 95%.

The weirs in the settling tanks at the north-side plant proved to be of insufficient length to pass the clarified effluent without carrying over light matter. To remedy this condition a number of 2-in. pipe siphons have been installed. As many of these are kept in use as may be needed at any time.

For compressing the air at each plant Sturtevant No. 10 blowers are used. These are designed to work under a pressure of 5¼ lb. total, 4¼ lb. of this being hydrostatic pressure on the filtros plates.

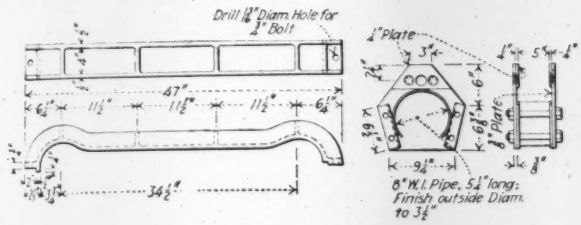
Tests of Concrete in Tension

Briquettes in Rich Mix 5 Inches Square at Breaking Section Broken at Periods Up to Twenty Months

By T. H. Carver and J. H. Quense
Water-Supply Engineer and Assistant Water-Supply Engineer, City Engineer's Department, Seattle, Wash.

LARGE-SIZE tension tests of concrete briquettes have been made in connection with a reinforced-concrete pipe line for the City of Seattle. Though they have not been extensive enough to establish general rules, the results are presented here for such value as they may have in the design of reinforced-concrete structures of rich, high-grade concrete when it is desirable that sufficient steel be used to prevent tensile cracking of the concrete at mixing loads.

The specifications for the concrete pipe called for concrete mixed in the proportion of one part cement to 1½ parts sand and 2½ parts gravel, but the contractor



DETAILS OF BRIQUETTE MOLD AND GRIP

elected to add 21 lb. of cement to each batch, making a mixture of 1 : 1.42 : 2.36, a barrel of cement being considered to be 3.5 cu.ft.

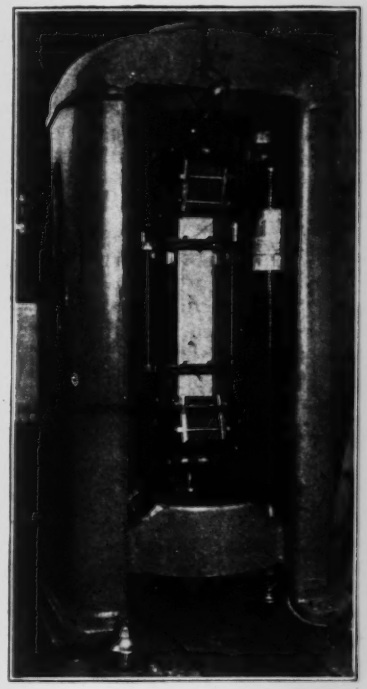
Test briquettes were made in the yard where these pipes were cast, the concrete being taken from the regular mix. In all ten briquettes were made and tested at ages from 57 to 609 days. Two brands of cement were used, both produced by plants near Seattle. It was subjected to the usual laboratory tests and showed from 89% to 95% passing a No. 200 sieve. Briquettes of one part cement and three parts standard Ottawa sand developed an average strength of about 330 lb. in seven days and 490 lb. in 28 days. Sand and gravel were of first-class quality, clean and carefully graded. An average analysis of the combined aggregate was as follows:

Passing	Percentage	Passing	Percentage
1-in.	100	No. 6	53
¾-in.	96	No. 10	51
½-in.	88	No. 20	47
¼-in.	66	No. 50	42
No. 4	59	No. 100	41

While the curve of the total mixture as used resembles Fuller's curve in general form, it was found necessary to use a larger percentage of small gravel. The amount of water used was carefully controlled and averaged about 19.5% by weight. Concrete was machine mixed in four sack batches, each batch remained in the mixer three minutes, the machine running at the rate of 16 turns per minute.

The specimens were carefully made and were kept moist by covering with wet burlap for about sixty days when they were stored in the laboratory. They were dry when tested.

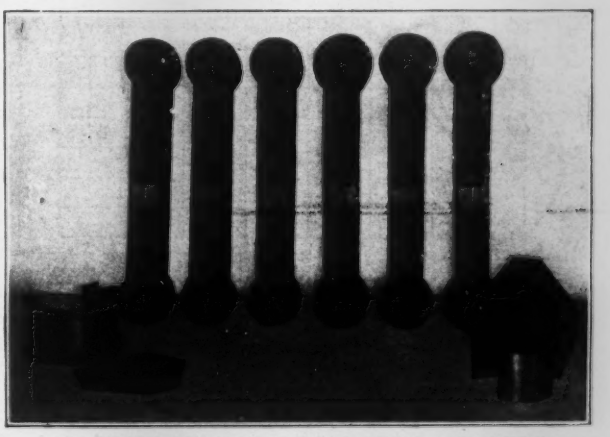
The briquettes were 5 in. square in section, 42 in. long and weighed about 100 lb. They were formed in cast-iron molds, having machined surfaces against which the concrete was placed. The shape of the briquettes is shown in the drawing, which also shows the heads, or clamps for securing them in the testing machine. In placing the specimens in the clamps, a steel ring formed of a short piece of wrought steel pipe, 8 in. in diameter, machined to a true cylindrical surface on the outside, and having one side cut away, was slipped loosely over each end, the intervening annular space of about ½ in. being filled with molten sulphur. The bearing surfaces of the clamps were machined to parallel planes where contact was made with the steel rings and were oiled to prevent twist due to binding after the specimens were placed in the testing machine. In spite of these precautions there seemed to be a tendancy for the specimens to break near the upper clamp.



CONCRETE TENSILE SPECIMEN IN MACHINE

Specimens A2, B3, C2 and C3 were broken on a machine in the testing laboratory of the University of Washington. This machine was not large enough to take the specimens and it was necessary to extend its capacity by raising the head and supporting it on temporary wooden struts. This arrangement, of course was far from ideal, but it is believed the results secured were good. All other specimens were broken on a 350,000-lb. Riehle machine recently installed in the laboratory of the City Engineer's Department. This machine, with a specimen in place, is shown in a view herewith.

The electric contact extensometer, reading to 0.0001



CONCRETE BRIQUETTES BROKEN IN TENSION

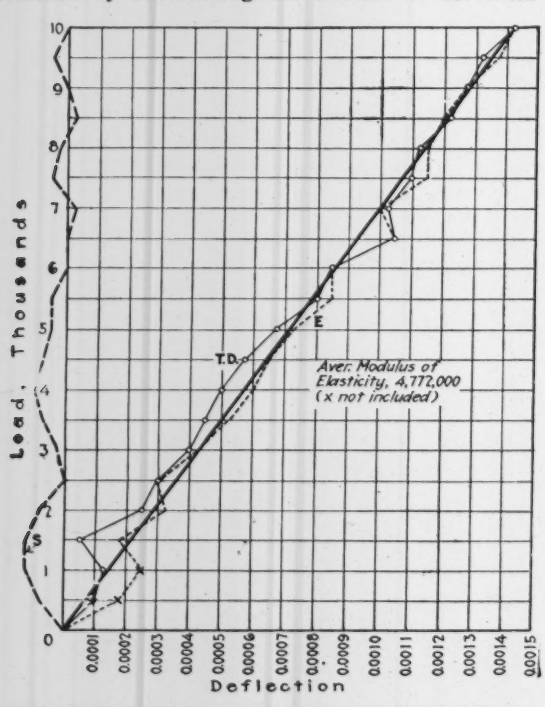
in. which was especially designed and constructed for this work is also shown. The gage length is 18 in.

In running a test, a load increment, usually 250 or 500 lb., was applied. The machine was then stopped and simultaneous readings taken, by two observers, of the right and left micrometers respectively, and recorded to show the increment of deformation. The load was then released and a period of one minute allowed for the specimen to attain its set deformation when readings were again taken, careful observations established that this was time enough for final set to take place. The machine was then started, another load increment applied, read, recorded, etc. All specimens were tested to failure but the extensometer was always removed before this occurred.

A general summary of ten of the tests is given in the following table:

Specimen	Age at Test Days	Breaking Load Lb. per Sq. In.	Average Modulus of Elasticity	Extensometer Removed at Lb. per Sq. In.
A2	58	268	5,030,000	97
B3	57	333	5,830,000	107
C2	60	278	5,996,000	189
C3	234	378	5,870,000	269
F1	585	445	4,904,000	207
F3	609	492	5,785,000	342
G1	562	473	4,952,000	187
G2	565	480	4,918,000	337
G3	566	431	4,772,000	380
G4	567	430	5,140,000	380

A typical test curve is shown in the accompanying diagram. The curve of total deformation is shown in a solid line, marked T. D., the set by a dashed line marked S, and the elastic curve by a dotted line marked T.D., the set by a dashed line marked S, and the elastic curve by a dotted line marked E. The elastic curve is determined by subtracting the amount of set from the



DEFLECTION-LOAD DIAGRAM FOR SPECIMEN G-3

total deformation at each point of observation. It is from the values of the elastic curve, that is, total deformation less set, that the modulus of elasticity is computed.

The heavy straight line that is drawn from the origin of coördinates is an ideal curve determined by dividing the load by the average modulus of elasticity. This ideal line follows the true elastic deformation curve fairly well in most of the tests.

Perhaps the most interesting thing developed by the tests is the fact of the permanent set becoming negative in some cases, one of which is shown on the diagram presented.

Just why this is so is not clear to the writers and no explanation is offered. The same characteristic has been observed by other experimenters, notably by Ira H. Woolson, as reported by him in *Engineering News*, June 1, 1905, p. 561.

Problems of a British City Engineer

SPEAKING before the (British) Institution of Municipal and County Engineers, F. W. Bricknell, city engineer of Hull, commented on several of the after-war problems of the British municipal engineer. He said in part:

"The third problem is that of bringing the cost of routine work and also that of street and sewer construction to such a figure as can be covered by a not intolerable increase of the rates. With average weekly wages doubled, cost of materials more than doubled, and assessments stationary, it is difficult to see how the doubling of rates can be avoided.

"The first cost to be attacked is that of labor. The old class of navvy and horseman, who was recruited from the country, has almost disappeared from the towns, and most of those who are in the towns can find easier and better-paid employment than that offered by a municipal body. The townsman has an inferior capacity for heavy work and a very strong prejudice against it. The obvious policy, therefore, is by some means to cut out the heavy work and endeavor to staff public works with men who will use their heads. A simple example is the use of scarifiers to break up macadam roads. Formerly these were not used in Hull because they would displace labor. Now they have to be used because pick work is unpopular.

"The loading of vehicles is work which cries out loudly for mechanical assistance. Costly vehicles are kept standing when they might be running, and good horsemen and motormen are lost because, being good, they can obtain work in connection with mills, etc., where they do not have to handle their loads. The writer has been able to obtain the use of high-level coal cells, and to obtain delivery of a certain amount of road metal and fuel in hopper wagons, which is an admirable solution so far as it goes. Some material landed at wharves by crane can be taken direct to its destination, but there remains a great deal which has to be picked up in the yard and elsewhere. There are some inexpensive mechanical loaders which deal well with dry macadam, gravel, etc., but tarred material is a problem, and destructor clinker is even more unpopular with the man, and there is more of it. The average cost per ton is probably four times what it was ten years ago.

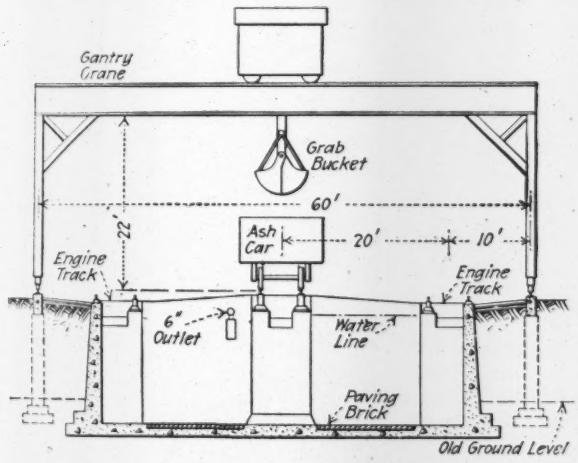
"The cost of refuse destruction has for long been somewhat of a bugbear. During the war not only has the cost of wages more than doubled, but the character of the refuse has changed, its calorific value having become almost nil, and the so-called clinker increased to about 50% of the original weight."

Railway Ashpits of New Design

Sides Are Vertical Instead of Sloping and Ash-Car Track Is on Center Line Instead of Being Outside the Pit

A WATER-FILLED ashpit having vertical walls and a central ash-car track on a concrete trestle is one of the features of two engine terminals at East St. Louis, Ill., and at Bremen Ave., St. Louis, Mo., for the Terminal Railroad Association of St. Louis. In most ashpits of the water-filled type a Y or V section is adopted, the engine tracks being placed over sloping sides which divert the ashes to the central part of the pit, while the ash-car track is at one side. This construction is employed at an engine terminal described in *Engineering News-Record* of July 3, 1919, p. 24. In the St. Louis design the ashes accumulate along the sides and extend over the space between the engine tracks and the ash-car track, whence they are removed by a grab-bucket. This same design has been used at other points on the Terminal Railroad.

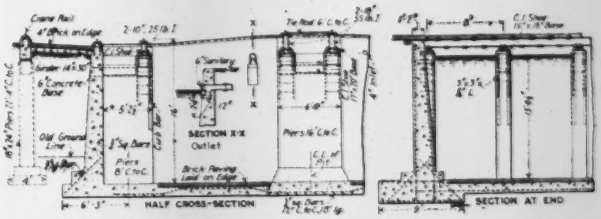
A rectangular section was adopted for the reason that such an ashpit would cost less than one with sloping walls, less concrete being required. It is not considered that this affects materially the capacity or



WATER-FILLED ASHPIT HAS VERTICAL SIDES AND CENTRAL TRACK FOR ASH CARS SERVED BY GANTRY CRANE

utility of the pit, because the ashes will slide as freely on themselves, if lateral support is removed, as on a concrete surface. It is stated that actual operation has proved that this form of construction is not objectionable in any way. The central track for ash cars has the advantage that ashes can be taken out of the pit without interference with its use by locomotives. There is also a large amount of water that drips from the grab-bucket and the ash-car which is a source of annoyance and is scattered over a large area if the ash-car track is on one side of the pit. This may be particularly troublesome in winter. With the central track, the water runs back into the pit, causing no trouble in mild weather and a minimum of trouble even in extreme cold.

Each pit is about 44 ft. wide and 16 ft. deep, with 12 ft. of water. Its length is 112 ft., or sufficient for two locomotives on each track. Along each side are piers spaced 8 ft. on centers, these piers carrying

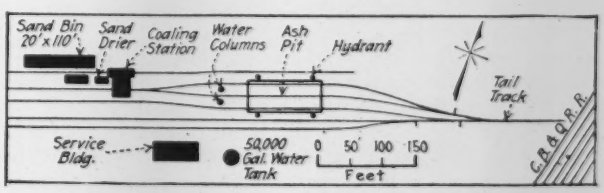


DETAILS OF ASHPIT AND CONCRETE CRANE GIRDERS

girders for the inner rails of the engine tracks, while the outer rails are carried by the side walls. Along the center of the pit is another row of piers, spaced 16 ft. on centers, to carry the girders for the ash-car track. Each girder is composed of a pair of I-beams with concrete filling, 10-in. beams being used for the 8-ft. spans and 18-in. beams for the 16-ft. spans. They rest on cast-iron shoes anchored to the concrete, and similar shoes on the side walls support the outer rails. Steel clips to hold the rails are secured by bolts through the flanges of the I-beams. Tie-bars between the webs of the rails maintain the gage of the central or ash-car track, but are not used on the side or engine tracks. All track and crane rails are 80 lb. per yard.

Water is supplied through a 4-in. inlet pipe at one end. At the same end is a 6-in. overflow or outlet pipe with sewer connection. The end of this latter pipe is capped and has a T-branch opening downward into a recess in the concrete wall, so that surface scum and dirt do not foul the inlet. The concrete floor is flat, and in the spaces between the rows of piers, where the grab-bucket operates, it is paved with vitrified brick on edge, this paving being grouted with cement. The bottom has no outlet drain or sewer connection, as it was considered that the ashes would soon clog both the outlet and the sewer. Should it be necessary to drain the pit, pumps must be used, but such a necessity is not anticipated. Reinforced concrete of 1:2:4 mix is used throughout, and for the walls and floor it is made waterproof by the addition of hydrated lime in the proportion of about 10% of the cement.

A gantry crane handles the ashes at the East St. Louis terminal, as shown on one of the drawings. This spans the pit, traveling on rails 60 ft. apart, and upon it is a traversing trolley which operates the 2-yd. grab bucket. As the site is filled ground, the rails for the gantry are carried on heavy concrete girders, 14 x 30 in. in section, which have a span of 22 ft. 4 in. and are supported by columns with footings in the



ENGINE TERMINAL WITH STUB TRACKS AT BREMEN AVENUE, ST. LOUIS, MO.

solid ground beneath the fill. The rails rest on ¾-in. plates and are secured by clips on anchor bolts embedded in the girders. The crane travels on four wheels and one wheel on each side is driven by gearing. Current is taken from an overhead wire for a 15-hp. motor on the hoisting trolley and a 15-hp. motor for

the propelling gear. At the Bremen Ave. yard a locomotive crane with grab-bucket is used to remove the ashes.

The ashpit at the Bremen Ave. terminal is used mainly by the switching engines employed in the terminal service, and about 30 engines have their fires cleaned in 24 hours. During the busiest times four engines can have their fires cleaned in 20 minutes. Two hydrants are arranged on each side of the pit, while a 300-ton coaling station and two 10-in. water columns are located near one end. This is a stub and terminal, with the three pit tracks and two outside tracks all converging on one tail track beyond the ashpit. The ashpit design and the terminal layouts were prepared under the direction of H. J. Pfeifer, chief engineer of the Terminal R.R. and now chief engineer of the St. Louis and East St. Louis Terminal District, United States Railroad Administration.

Paved Roads Built in Installments From Dirt Roads

Iowa Lays Base for Paved Roads by Progressively Building Up Earth Road—Engineers Direct All Work

STARTING with the axiom that the foundation structure of every paved road is a dirt road, Iowa has progressively built up its prairie-soil roads, so that on nearly 3000 miles a permanent paved road structure exists except the hard surfacing proper. Specifically, with 104,084 miles of earth road and with an annual expenditure of less than $140 per mile, Iowa has in barely five years completed 2900 miles of grade and structures ready for hard surfacing; has brought 13,000 miles additional partially to section and grade; has constructed nearly 40,000 concrete and steel bridges and culverts, and has kept its entire mileage in condition to accommodate traffic. All construction, wherever it has been performed, is uniform in design and materials. The maintenance has been the same in character and methods in every township. In terms of money, one-half of every dollar spent on earth roads has been for work which contributes to an ultimate system of paved roads. The other half of the dollar has kept the earth roads in condition to accommodate traffic.

General Program of Operations

With limited income; a prairie soil with no stone and very little gravel; a uniform use of roads and the consequent necessity for keeping the entire 104,084 miles in service, the development program was based on a few fundamental conclusions, One conclusion was that if all earth roads were built up, as they could be, to furnish fine traffic facilities during the nine dry months of the year, better highway service would be provided than if a few expensive all-the-year roads were constructed and the remaining mileage was left unkept. Another was that by working with machine graders systematically to plan, a large amount of widening and ditching and a material amount of longitudinal grading could be done in the regular course of building up the earth roads, thus creating the underlying element of future permanent roads. The third conclusion was that since bridges and culverts had the same service to perform whether the roads remained earth roads or became paved roads, these structures should, as far as possible, be designed and constructed as permanent work.

Under the general policies enumerated, plans were prepared having in view (1) construction to permanent grade and (2) construction to temporary grade. Construction to permanent grade meant completion to transverse and longitudinal profile, with ditches and permanent bridges and culverts. Where funds were not available for construction to permanent grade, provision was made for partial improvement. A cut through a hill or a fill across a valley was permitted, to be brought partly to depth or height in such manner that the work accomplished would contribute to the final construction to permanent grade. Where even longitudinal grading was beyond the means available, the road was widened to transverse profile at the natural grade. In general, the broad plan was to provide for road improvement to any degree desired, but always to perform the work so that it was a step toward final, permanent construction.

In detail, the plans provided standard requirements for all classes of construction and standard designs for all types and sizes of structures ordinarily required. Earth-road sections were prepared which could be widened and shaped from the existing prairie roads almost entirely by scraper graders, and could be kept to surface largely by dragging. Sections were also provided for gravel and other surfacing, but the main purpose was to develop standards for building up earth roads to width and with adequate ditches. In respect to bridges and culverts the plans were more elaborate. The assumption, as stated, was that these were, ordinarily, to be permanent structures. The plans, therefore, presumed construction of concrete and of steel, and designs were prepared for a large variety of conditions and for many dimensions of waterway, and general requirements were laid down for materials, loadings and stresses.

Standards were set, but adherence to these standards was conditioned on common sense. A tendency to fit standard designs, without change, into local conditions was discouraged. Instead, the policy urged was to prepare, in conformity with the standard, a plan fitted to each locality. For large or unusual structures special designs were permitted if the designs conformed to the requirements laid down by the adopted standards. In brief, the purpose of setting standards was to secure uniformity in type, character and quality, and not to provide custom-made bridge and culvert plans.

General Plan for Administration

In Iowa the units of state, county and township have distinct functions of administration and control in road affairs. The state is represented by the State Highway Commission and a corps of engineers and assistants appointed by the commission: The county is represented by the county Board of Supervisors, consisting of three to seven men elected to the position, and the county engineer appointed by the supervisors. The township is represented by the Board of Trustees elected to the position and the township superintendent appointed by the trustees.

The function of the State Highway Commission is to establish standards, both plans and specifications; to enforce these standards, and to devise and enforce general rules providing for uniformity of action for

the county and township road officials in the administration of road and bridge work.

The function of both county and township is to initiate and plan road improvements and to appropriate and expend the money for these improvements and for maintenance.

This general plan of administration was laid down by the basic road law of 1913. The law also established a number of details which bear directly on procedures. It placed the county engineers partially under the control of the commission, by empowering the commission to remove them for incompetency. It delegated all permanent bridge and culvert construction on all roads to the county supervisors, and thus insured engineering design and direction. It concentrated major improvements on main roads by dividing the state road mileage into county roads (16,000 miles) and township roads (88,000 miles). It placed a check on expenditures by requiring counties and townships to make financial reports to the commission and by requiring all contracts exceeding $1000 to be awarded after competitive bidding and all contracts over $2000 to be approved by the commission.

Commission Controls County Engineers

The engineering organization for road work consists of the Highway Commission engineers and the county engineers, over whom the commission has control in three ways: (1) The county engineers must plan in conformity with the commission standards; (2) they must render an accounting of all work to the commission, and (3) they can be removed by the commission for incompetency. As organized at present the commission has a chief engineer, four department engineers and nine district engineers, each with such assistants as are called for by the work being done. There are 99 county engineers. A district engineer has direction over 11 counties and has headquarters in each district. The county engineers have headquarters at the county seats. Every section of the state thus has equal engineering representation before the commission, and, conversely, the commission has equal engineering direction over every portion of the state.

Engineering direction of all permanent construction is obligatory under the law. Permanent work comprises concrete and steel bridges and culverts; grading and widening roads to or toward permanent grade; tile drainage, and surfacing with gravel, macadam, sand-clay or some form of paving. The procedure is alike in all cases whether the project is to complete a dozen miles of road to permanent grade or to construct a single culvert. The project is initiated by the county supervisors and the county engineer prepares plans, conforming (the law makes this obligatory) to the commission standards. Contracts are awarded by the supervisors, and the county engineer supervises the execution of the work. If the contract exceeds $1000 a public letting is required by law; if it exceeds $2000 it must, including plans and specifications, be approved by the commission. Annually the county engineer renders to the commission an accounting, on forms provided by the commission, of all work done.

Though the county initiates, plans and executes all permanent improvements, commission engineering control is complete unless the law is evaded. Opportunity for evasion is restricted by constant oversight. Contract lettings are widely attended by the district engineers, who are also constantly over all work under construction in their districts.

Local practices capable of general use were investigated and reported in the monthly service bulletin published by the commission. County manufacture of concrete pipe, county operation of gravel pits, winter concreting methods, motor-truck haulage of gravel, cost of bridge painting, and road-oiling experiences were some of the subjects of these reports. Materials prices were published. Recently instruction pamphlets for making surveys have been published, and others are being prepared. Laboratory and field tests of materials and methods of construction were conducted. These tests included paints, road oils, wood preservatives, concrete materials and culvert pipe. The data obtained were incorporated in new or revised standards or made available by publication.

Investigations of wide scope included a stream and waterway survey to determine the proper sizes of bridge and culvert openings; a census of available sources of road materials, and a main-road traffic census made at 47 stations in 17 counties. Almost two-thirds of all rural-road traffic was found to originate in towns and to return to towns. Nearly 86% of the traffic was motor-driven. Purely freight vehicles were a small percentage of the total. Weight records kept at four stations for 42 days gave an average weight of 2636 lb. per vehicle. The daily average weight of traffic was nearly 1,000,000 lb. These data were utilized in driving home the lessons that town residents should pay their share of the taxes for rural roads, and that roads must generally be built to carry motor-driven traffic.

Construction Accomplished

In five years, from 1914 to 1918, by the methods outlined there have been completed 2900 miles of permanent grade and 37,700 permanent bridges and culverts. The completed grade is ready for hard surfacing with any kind of pavement desired; the bridges and culverts are of concrete and steel. These figures do not present the total permanent work accomplished. About 1100 miles of road have been brought to temporary grade—that is, widened to transverse profile and with hills cut down and valleys filled part way to longitudinal profile. In addition, 12,000 miles of road have been widened to transverse proqle without change in the natural grade. Besides this permanent work, an average of 15,000 miles of road have been dragged an average of 29 times a year, ordinary repairs have been made, and a total of 85,700 temporary bridges and culverts have been built.

The average expenditure per mile for all purposes, as tabulated by the Highway Commission for four years, has been as follows:

Item	1915	1916	1917	1918
County roads	$191	$204	$223	$238
Township roads	40	44	46	45
Bridges, all roads	66	69	71	67
Average for all roads	130	138	146	135

The records show that about 40% of the expenditure on county roads has been in permanent work, and that about 60% of the expenditure for bridges has been for concrete and steel structures. In addition, at least 10% of the township road expenditure has been for construction of permanent character. The total engineering cost has been less than 4%, of which about 0.75% is chargeable to the highway commission.

Construction Progress on Canadian Niagara Power Project

Excavation Well Under Way on Queenston-Chippawa Canal Which Will Develop Most of Head Between Two Great Lakes

WORK on the new hydro-electric development at Niagara Falls, which the Hydro-electric Power Commission of Ontario started in 1918, is progressing at an expected rate of speed. Some little difficulty has been met in holding the slope in the deep cuts in the earth overburden, but this has not caused serious retardation, and the prospect now is that power will be available in 1921. Work is being carried on under

PLAN OF QUEENSTON-CHIPPAWA POWER DEVELOPMENT

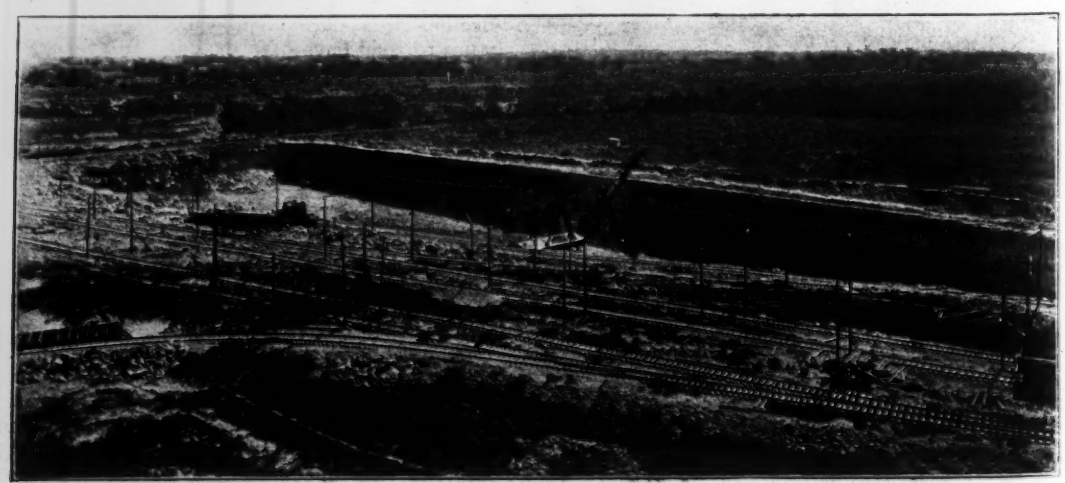
force account by the engineers of the Commission, and will be continued throughout the winter, as it was last winter.

The general features of the Queenston-Chippawa development, with the progress up to that time, were described in *Engineering News-Record*, Oct. 31, 1918, p. 801. It is, in brief, a scheme for developing nearly the full head of the Niagara River between Lakes Erie and Ontario by a canal running from Chippawa, about two miles above Niagara Falls at the mouth of the Welland River, to Queenston, about a mile above the Lake Ontario end of the Niagara River. The difference in elevation of the two lakes is 330 ft. The new plant will operate under a head of 305 ft., 12 ft. of the loss being due to the drop in level to the intake of the Niagara River from Lake Erie to the Welland River, 8 ft. to the gradient of the canal, 2 ft. to the drop in Niagara River level from power-house discharge to Lake Ontario, 6 in. due to friction in the canal and 2½ ft. loss in friction in the penstocks. As at present designed, the plant will develop 300,000 hp. with a flow of 10,000 cu.ft. per second or a development of 30 hp. for each cu.ft. per sec. The old Niagara River power plants developed from 12 to 15 hp. per sec.-ft., the new Ontario Power Co.'s development on the Canadian side about 17, and the new Hydraulic Power Co.'s development on the American side about 20.

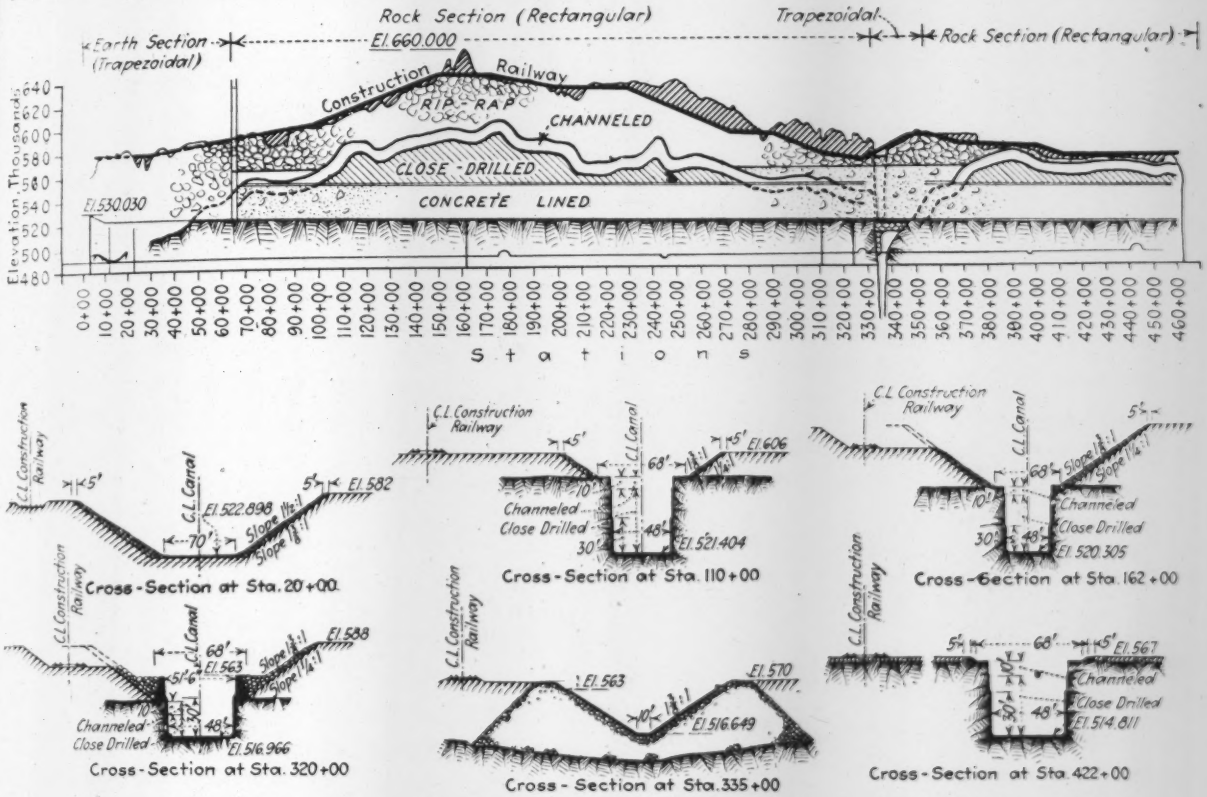
Under the international agreement, of the 220,000 cu.ft. per second flow of the Niagara River 56,000 sec.-ft. can be diverted for power purposes. Of this total, 36,000 has been assigned to Canada and 20,000 to the United States. At present the Ontario Hydro-electric Power Commission has control of 17,790 sec.-ft. of the 36,000 permitted to Canada, of which 11,180 is developed through the Ontario Power Co., a private plant which was bought by the Commission two years ago. It is evident, therefore, that the Commission will have to shut down some of the power in its older system as soon as it commences to operate the Chippawa development at its 10,000-cu.ft.-per-sec. capacity.

The project comprises 4½ miles of river canalization and 9 miles of power canal dug in the dry. The river canalization is in the Welland River whose direction will be reversed from its present mouth up to the canal intake where the control works will be built. The canal extends across high land beyond the Niagara Gorge to the power house which will be built at the foot of the gorge at the river elevation. Water will be delivered to the power house by penstocks laid on the slope of the bluff.

The mean velocity will be 2 ft. per sec. in the Welland River channel with a gradient of 0.63 ft. per mile and 6 to 7 ft. per sec. in the canal where the gradient is to be 1.1 ft. per mile. The river channel section is being excavated by dredge and cableway, to provide sufficient waterway. Canal excavation is largely through rock with a heavy earth overburden. The first 1¼ miles of the canal just beyond the river is in earth section; the remainder is in rock with the exception of a short earth section opposite the Whirlpool, where an old gorge, probably a former bed of the Niagara



LOOKING OVER FOREBAY EXCAVATION TOWARD INTAKE. (BACKGROUND IS ON OTHER SIDE OF NIAGARA RIVER)



PROFILE AND SECTIONS OF QUEENSTON-CHIPPAWA POWER CANAL AROUND NIAGARA FALLS

River, drops the rock bottom so deep as to make it impossible to found the canal on rock.

The earth section at the river end of the canal is trapezoidal in shape, 70 ft. in base width with an earth slope of $1\frac{3}{4}$: 1, and a riprap facing 5 ft. thick at the top and sloping $1\frac{1}{2}$: 1. The section in rock is trapezoidal, 48 ft. wide and varying in depth up to 60 ft. The earth overburden slopes back $1\frac{1}{4}$: 1 with a riprap face 5 ft. thick at the top and on a slope of $1\frac{3}{4}$: 1, according to the details shown in the accompanying drawing. Back of the Whirlpool the section is triangular on a heavy fill, with a lining of concrete. The rectangular rock cut is channelled for the first depth of 10 ft. and close drilled for the remaining depth. It will be lined with concrete for a height of 30 ft. from the bottom.

At a distance of about 2400 ft. from the river the canal widens out into a forebay 1000 ft. long and 300 ft. wide at the intake gate. The penstocks are of riveted steel plates 14 ft. in diameter and about 450 ft. in length and extend down the steep bank of the gorge and the river from the forebay to the power house. No surge tanks or standpipes will be required. At present four main penstocks are to be built and one exciter penstock 5 ft. in diameter.

The initial power installation consists of two 55,000-hp. turbines driving the generators. Full details of the generating machinery are not yet available. However, two of the turbines have been let to the Wellman-Seaver-Morgan Co. and their generators to the Canadian Westinghouse Co. It is expected that four units will be installed at the present time.

The work at present may be divided into that on the river, that on the canal proper, and that on the power house. In the Welland River a dredge is working up from the mouth of the Niagara River and has reached the Michigan Central Ry. bridge, about a half-mile from the mouth. This dipper dredge is spoiling into scows which are being taken out into the Niagara River and dumped. A cableway excavator farther up the river has done a certain amount of work but is now operating at full capacity. Between 3,000,000 and 4,000,000 cu.yd. of earth is the total excavation in the river. About one-quarter of this has been removed.

The larger part of the work in the canal has been done, beginning at the forebay end. From that forebay, which is about Sta. 470 to Sta. 200, practically all

STEAM SHOVEL WORKING DOWN NIAGARA RIVER BANK AT POWER HOUSE SITE

of the earth overburden has been removed by the heavy longboom electric steam shovels described in previous articles in this journal. From Sta. 200 to Sta. 0 at the Welland River only some pilot cuts have been started but the beginning of the earth excavation has been made. Between Sta. 200 and Sta. 273 the steam shovels are now working removing the overburden. The forebay itself is practically completed and channelers and drills are working in the rock cut between the forebay and the end of the earth overburden excavation. The construction railway is completed, all except a short section at the upper end and is in operation carrying trains of earth and rock cars to the spoil dump, which is on a spur two miles to the west of the canal line.

Two of the big concrete bridges, those carrying the

GANG OF CHANNELERS MAKING FIRST ROCK CUT

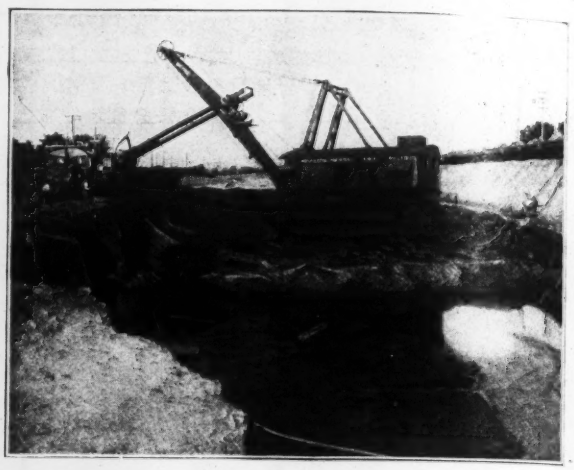
St. Catharine's & Thorold Electric Ry. and that carrying the Wabash Ry., are completed. The twin bridges carrying the Grand Trunk and the Michigan Central are under way, the foundations being all done at this time. At the power house site the whole face of the cliff has been stripped and a construction railway is being built down to the river edge from a connection to the main line road, about a mile below the power house site. A steam shovel has been worked along about 50 ft. above the river level and is engaged in excavating the power house site. The heavy rock-filled section across the Whirlpool gully is well along, about 60% of the rock fill being in place and 80% of the

STEAM SHOVEL TAKING OUT FIRST ROCK LIFT

gullies which run back from the main line ng filled.

A number of the special methods used the construction of the canal have been descri in short articles which are appearing in the "I s to the Contractor" section of this journal.

The Queenston-Chippawa Canal is being ilt under force account by the Hydro-electric Power mission



EIGHT-YARD SHOVEL REMOVING OVERBURDEN IN WET GROUND

of Ontario, of which F. A. Gaby is chief engineer, and the work itself is in charge of H. G. Acres, hydraulic engineer, with J. B. Goodwin, works engineer; George Angell, general superintendent of construction; A. C. D. Blanchard, chief field engineer, on the ground.

Renewal of Ladder Tracks in Yards

In maintenance work at large classification yards the rebuilding of ladder tracks is the most difficult operation, according to a report presented at the recent annual meeting of the Roadmasters' and Maintenance-of-Way Association in Chicago. Everything possible should be done in advance of cutting the track. Material must be checked, rails cut and drilled for lead rails, and switch ties marked as to their length so that they can be identified at once. Where conditions permit, all material should be distributed along the ground, opposite the ladder, but if this is not possible the material should be assembled on cars so that it can be unloaded in proper order. Arrangements should be made to have traffic suspended over the ladder for four hours, during which time, says the report, a gang of 40 experienced men can renew three switches. Where the track cannot be given up for any definite time, the new rails must be laid on the old ties, one switch at a time, the ties being then renewed singly. This method is expensive and is not conducive to good work. All old material should be removed to a safe place on the day when the work is done, so that no obstruction to the yard men is formed. For track repairs in such yards, a designated track is usually put out of service for a day's work, and a car with supplies is set out on this track. The old material is placed on the car, and the track is left in good condition for the night work of the yard. If sufficient force is available, the track can be worked from both ends.

Experiences in Garbage Collection and Disposal at Akron, Ohio

Change to Hog Feeding After Two Years' Trial of Reduction—City Will Receive 85 Cents a Ton—Former Reduction Costs

By F. C. Tolles
General Superintendent, Bureau of Sanitation, Akron, Ohio

After experience with garbage reduction in a municipally owned plant operated first by the city, then by a company under lease, and then again by the city, during which latter period the plant was crippled by fire, Akron, Ohio, has let a five-year contract for disposal to the American Stock & Food Co., Alvah Brown, president. The city will receive 85c. a ton for garbage delivered within 4 miles of an existing reloading station. For distances over four and under five miles an additional allowance is made of 15c. per ton-mile. Akron's experience with both the collection and disposal of garbage seems worthy of brief record.

In January, 1916, the city, then having a population of about 110,000, put into operation, under city ownership and management, a reduction plant of 25-ton capacity. The process was the usual one of digestion with steam followed by percolation of the dried tankage with gasoline to recover the grease. Collections at this time were made under contract. In May, 1916, the collection contract was awarded to the Akron Garbage Collection Co., formed for that purpose, and in August, 1917, the operation of the plant was also turned over to this company under the name of the Akron Garbage Disposal Co. The contract then underwritten was for a period of five years, with privilege of a five-year renewal. The dual company was paid $3.12 per ton for the collection service and in turn paid to the city a yearly plant rental of $8200 (plant valuation $116,000). During its operation of the plant the Reduction Co. increased the capacity to 45 tons to meet the rapid growth of the city.

Collection service under this contract was very unsatisfactory, as was indeed the nuisance caused by the operation of the plant, though the latter was in no wise the fault of the operating company.

The 1918 report of the two companies furnished the following data:

GARBAGE COLLECTED—10,142 TONS

	Receipts	Operation Cost
Collection Co.—Collection	$30,856.06	$35,842.65
Disposal Co.—Products	63,134.89	61,886.75
Total	$93,990.95	$97,729.40

A slight profit on reduction will be noted, but it is very small considering the prices current for grease in 1918. The operation totals listed above include no items properly charged to capital account save the rental of $8200. Insurance and maintenance were included. Insurance is simply the fire insurance on the buildings; it, together with the cost of small repairs, is included under the head of "General Expense" and shows above as "operation cost," or cost to the company for both collection and disposal.

In January, 1919, the collection company, claiming breach of contract on the ground that the city had failed to pave the approach to the reduction plant, formally stated its intention to cease operations Mar. 1, 1919. The paving referred to had been held up by the National Capital Issues Committee, but the city elected to assume operation of both collection and reduction systems. The contractor's organization was also taken over. Equipment and plant installed by the contractor were appraised and purchased by the city for $96,174, of which $48,245 represented teams, trucks, barns, bins, etc., of the collection service. At the same time, funds to the extent of $54,000 were provided to add to the plant in an effort to recover greater value from the treated garbage and to lessen the odors of which complaint was common.

On April 16, 1919, a severe explosion wrecked the percolator room of the reduction plant. An investigating board of industrial chemists and engineers from the local rubber factories reported findings to the effect that gasoline vapors residual from the degreasing process had traveled until they came into contact with direct heat dryers two rooms distant, had there ignited and had flashed back to cause the major explosion in the percolator room. The accident resulted in the death of two men and the injury of four others. The loss to plant was estimated at $30,000. The digestors were put into operation within two days, since which time the plant has been so run, sterilizing the garbage and spreading it on the grounds.

With conditions as indicated, renewed study was given to the matter of garbage disposal in Akron, the technical studies being conducted by I. S. Osborn, Cleveland, as consulting engineer to the city.

Where originally located in 1914-15, the garbage plant site was situated in the Cuyahoga valley, well on the outskirts of town. With the rapid growth of the city, boundaries have been extended. Moreover, the operation of the plant drew considerable complaint from two of the principal residential areas and served to justify the presence of one or two odorous neighbors, newcomers to this section. City planning now contemplates the development of a boulevard and playground system in the valley. The aggregation of these facts made the city reluctant to increase its investment in a plant at that location. An estimate for an entirely new (Cobwell) plant of 100 tons capacity at some point remote from the city called for an expenditure of $472,000, with a net annual charge of $34,700. As counter to these, the project of feeding hogs was considered, and as the city was unwilling to undertake municipal operation bids were asked from private contractors. The first opening resulted in but one bid of unsatisfactory price. Readvertisement produced two bids.

Reviewing all the data in its possession, the city council, under recommendation of the public-service department, declared in favor of feeding to hogs, taking the stand that the financial conditions of the city and the uncertainties of its development rendered desirable a deferment of the final decision. In other words, the determination was not a final pronouncement, but a convenient and economical solution of the present-day situation, permitting the city to reopen the question later. Accordingly, a contract for disposal was awarded, as stated in the opening paragraph.

Under the terms of its contract the city is obligated to provide collection twice a week, May to November, inclusive, and once a week the rest of the year.

Collection at present is accomplished with 15 teams using Studebaker garbage wagons and centering the loads, to bins from which the material is relayed by a truck using a 10-cu.-yd. Lee body. The average wagon haul is 2½ miles. Plans for extension and improvement of service contemplate a gradual increase of the number

of teams and the immediate purchase of two or three delivery trucks. It is also proposed to experiment with convertible wagon-trailers and eventually to establish a second relay station. The need for improvement is decided, but financial restrictions are severe.

As furnishing information upon the finances of municipal operation of collection and disposal services, the following is pertinent: From Mar. 1 to Oct. 1, 1919, the city handled 7,588.3 tons of garbage at a cost of $8.94 per ton for both collection and disposal, exclusive of $1.45 per ton attributed to plant and equipment extensions, and also exclusive of interest and depreciation charges, which amount to about $2.05 per ton. The receipts from grease and tankage from March to June, 1919, amount to $7325. As noted before, the recovery of grease practically ceased June 16.

H. S. Morse is director of public service, and D. R. Thomas is superintendent of both collection and reduction.

Turntable Reinforced by Trussing To Carry Heavy Engines

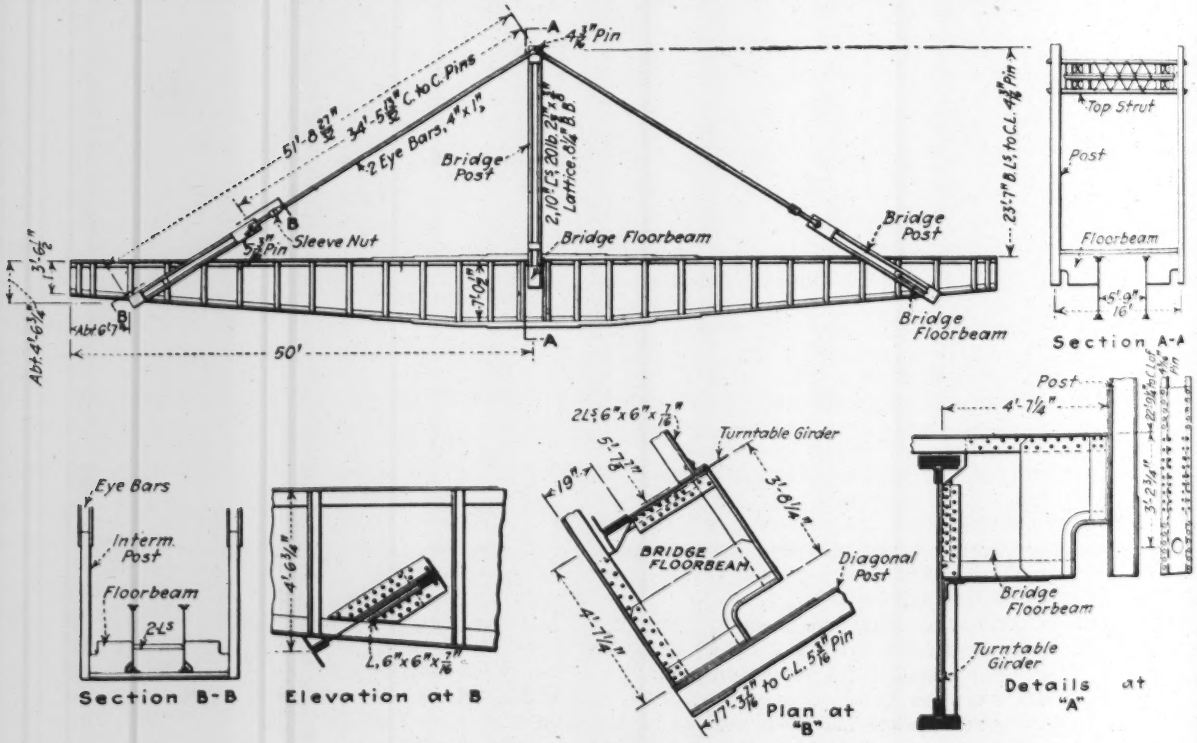
Girder Structure Fitted With High Center Frame And Tension Bars to Ends—Old Bridge Material Utilized

INCREASED strength and rigidity of a 100-ft. plate girder turntable on the Chesapeake & Ohio R.R., at Russell, Ky., has been obtained by trussing it with members salvaged from an old bridge span. The turntable was built in 1913, but new engines assigned to this railroad by the United States Railroad Administration were so heavy and so long that they caused excessive deflection at the ends. Reinforcement consisted in converting it into the bottom chord of a king-post truss, as shown in the accompanying drawing.

Material was utilized from a 150-ft. single-track through pin-connected truss bridge which had been taken down as inadequate for service. The two center posts with the floor-beam between them were used as a center frame, the web and bottom flange of the floor-beam being cut away at the middle so as to enable it to straddle the top of the turntable. The bottom flange compression in the floor-beam is taken by the loading girders between the webs of the turntable girders. Connection angles were riveted to the web of the floor-beam and the outside of the webs of the turntable girders. A strut formed of two old top struts riveted together was fitted between the heads of the posts.

Diagonals consisting of the original eyebars of the center panels are attached to the top chord pins in these posts and extend to attachments to the girders near the outer ends of the turntable. The bars connect to bottom sections consisting of the lower portions of the adjacent posts of the bridge. These latter posts in turn are riveted to two of the old floor-beams, which have their webs and top flanges cut away at the middle so as to straddle the bottom of the turntable. The posts and end floor-beams are inclined, lying in the same plane as the diagonals, with the floor-beam webs connected to the turntable girders in the same way as at the center frame. Sleeve-nuts in the eyebars enabled the truss to be brought into action. As many as possible of the old bridge connections were maintained in the new work.

This reinforcement material was fitted up in the railway shops at Huntington, W. Va., and was erected by the maintenance forces. The method was suggested by J. M. Staten, general inspector of bridges. The work was planned and executed under the direction of Crosby Miller, bridge engineer, Chesapeake & Ohio Railroad.



TURNTABLE TRUSSED BY OLD BRIDGE MEMBER

Bond-issue Highway Program in Salt Lake County

Both Scenic and Utilitarian Roads Built—Concrete and Bitulithic Only Hard Types Used, Latter Near Beet-Sugar Factories

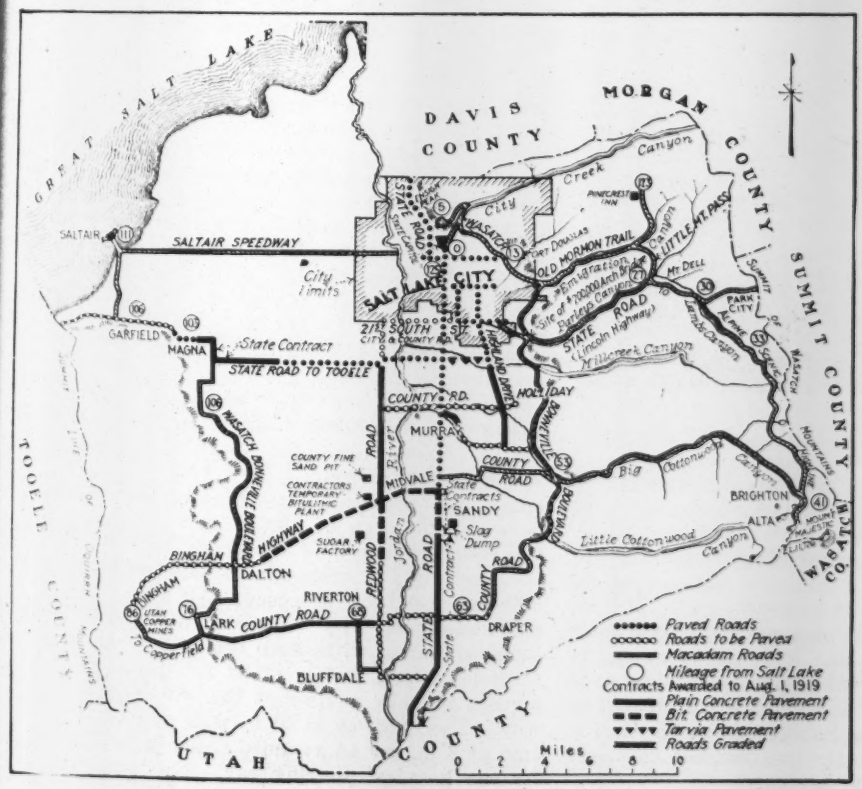
SCENIC as well as strictly utilitarian roads are included in the $1,500,000 highway program on which Salt Lake County, Utah, to Aug. 1, let contracts totaling $625,000. Funds available for highways are estimated at $27 per capita, or nearly twice as much as the next highest per capita in the country. Naturally, the most intensive development centers in Salt Lake County, where reside approximately 50% of the 400,000 people of the state.

In general plan, the economic roads grid the U-shaped valley to serve the intensively cultivated irrigated areas and to connect with important points on the west where mines or mining operations are located, as at Bingham, Magna and Garfield. On the east, transcontinental routes and scenic cañons are the objectives. The basis of the scenic part of the plan is a 125-mile drive skirting the whole valley on the shores of the ancient prehistoric Lake Bonneville, visible as a bench entirely around the valley. Added to this, as a rival of the Mountain Parks drive out of Denver, is a proposed Alpine Highland drive out of Lamb's Cañon to the summit of the Wasatch range, 10,000 ft. above sea level, with Brighton as the objective. The city was full of tourists all summer, but a bid for more and more of them is to be made by means of good roads.

The general scheme of construction, which was entered upon as quickly as possible after the armistice was signed, was to put men to work early in the spring on force account on grading operations in the foothills for the Bonneville Boulevard. The sand and gravel nature of the bench made work here feasible long before the more utilitarian valley roads could be worked, thus giving the engineers time to make surveys, estimates and plans for the hard-surfaced roads. Few of the scenic roads have had anything done on them except grading. Laborers suddenly became scarce about June, and the crews found work elsewhere or with the valley contractors. Much of the mountain mileage will need only shaping with a grader, as the material on the site is good road metal. Some oiling may be done, but there will be little real macadam.

On account of the uncertainties as to price, the contractors were not asked for bids on the materials. In consequence, a fairly large staff of engineers, inspectors and foremen has been necessary to keep track of the pits, quarries and loading stations, in addition to the regular engineering work. These men, 36 in number, are all under the supervision of the county highway engineer, who has a chief field engineer with four parties under him. More than 175 miles of new location had been made up to Aug. 1. A location party consists of three men on preliminary location, four on trial location, and four in a level party. The other three parties handling construction consist of a chief, a transitman and two rodmen. The inside work is under an office engineer who has a bridge engineer, a chief assistant and road designer, five draftsmen and a clerk.

The types chosen for the work were not influenced entirely by costs. Concrete and bitulithic on slag base and on so-called "black" base were about of equal cost. Bitulithic has been specified, however, on those roads in the vicinity of beet-sugar factories because the experience at Layton, in the northern part of the state, where it is said, disintegration of concrete has taken place rapidly due to the organic acid in the pulp hauled away from the factories for cattle food. This road was covered with Tarvia which peeled off later, bringing a portion of the concrete with it, indicating that the acids continued to work under the coating. From correspondence with the factories and with surrounding states, the engineers learned of similar experiences.



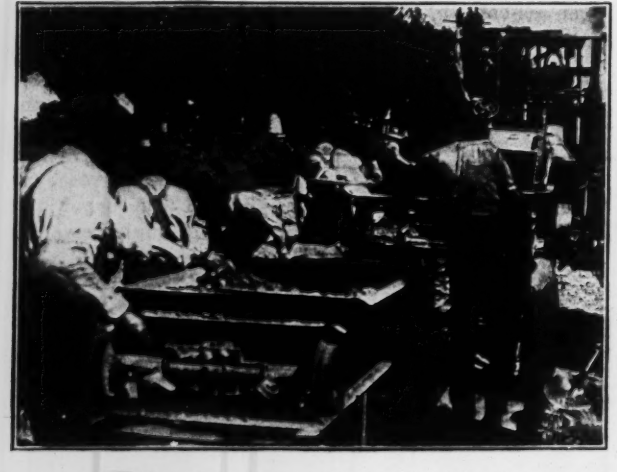
ROAD PROGRAM ON WHICH SALT LAKE COUNTY IS AT WORK

The concrete is an 18-ft. slab, 6 in. thick on the sides and 8 in. in the center, made with a 1:1.37:1.42 mix, so proportioned that there will not be an excess of mortar. The six-mile stretch on Redwood Road under contract by Ryberg Bros. is typical. The old gravel-macadam road is scarified to the new grade, following the old as closely as possible. Some of the gravel had been down 10 years,

but in most places sufficient material is left for shoulders. For 2½ miles a longitudinal drain will be necessary on the uphill side of the road, but the remainder has been well built up above the surrounding country. Sand and gravel from a county pit near the center of the section are washed over rotary screens with 400 gal. per minute, the output being 350 cu.yd. per day. Less than this amount of water leaves a filament of clay adhering to the stones, effectively preventing a bond.

Concealed expansion joints are inserted at the end of a day's work. Finishing is done by rolling four times and belting twice. Ponding for 10 days is practised, and the engineers are attempting to increase this period to 20 days. The road is opened to traffic in 28 days. Water problems are easily solved, because irrigation ditches parallel and cross the road at frequent intervals. A pump with pipe line, however, is installed to make the ponding operation sure. On this job a Koehring mechanical loader of the belt type is operated by 11 men, who easily keep the boom and bucket mixer turning out a batch every 1½ min. Once during the inspection by a representative of *Engineering News-Record* two of the four hoppers were discharged at once, apparently by accident, overloading and stopping the belt for a few minutes.

Of the bitulithic on black base, a stretch of 9.3 miles on Bingham Highway, just north of a sugar factory and on Redwood Road east of the factory, is typical. Practically all of this road is old gravel macadam, so there is good foundation for the 3-in. base, which con-

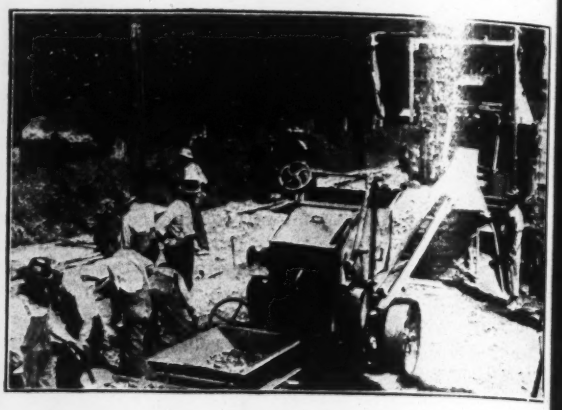


FOUR HOPPERS LIKE THE ONE IN FOREGROUND FEED ONTO BELT CONVEYOR

sists of an asphaltic concrete with the aggregates graded down from a 2-in. gravel. It is rolled with a 10-ton roller, and a 2-in. bitulithic layer is put on top, dependence being placed on the original foundation to carry most of the load directly. The old material varies from 6 to 24 in. in depth. The contractor, the Cliffton, Applegate & Toole Co., has built a portable plant near the junction of the Bingham and Redwood roads at the Salt Lake & Utah R.R. crossing, thereby giving easy shipping accommodations. The county has a pit of fine sand about a mile north, and has erected a trestle for loading by slip scrapers directly into gondola cars. It furnishes this at a cost of 60c. per yard.

For the 4-in. slag base which is being used by the state on State St., material 4 in. and and rolled, then covered with a crushe in. and under, rolled into the interstices top coat of regular bitulithic is applied. Sandy is available, a crusher having by the contractor to furnish road mate

Practically all of the mountain work



TRIPPING END HOPPER ONTO BELT

excavation only. The state forces are now at work in Parley's Cañon widening an existing road to 24 ft., as this is the Lincoln Highway entrance from the east and carries a heavy traffic in addition to that of Park City, a mining town. A steam shovel and a five-ton truck hauling a grader are the large tools used. Work on the surveys of the Alpine Highway up Lamb's Cañon have been completed—that is, beyond the end of the present narrow one-track steep-grade existing mountain road. In the first four-mile section which is about to be let a long "hairpin" curve with 40-ft. radius on the loop is the first feature. There are also one 80-ft. and three 100-ft. radius curves necessary to gain the crest, but there is only 500 ft. of solid-rock excavation in this distance. The maximum grade will be 5%. To check cars coming up to sharp curves on grades, the lower end is made the maximum and the upper end leads off on a flattened grade. The latter permits cars to slacken speed coming down. Beyond the head of Mill Creek, where the steepest portion will be located, the road will wind in and out around the peaks, hitting all of the saddles on the top of the range until it reaches Mount Majestic at a point much nearer the peak than indicated on the map.

Structures of importance on the county roads are not numerous. A $200,000 concrete arch bridge on the Bonneville Boulevard over the mouth of Parley's Cañon, for which tentative designs have been made, is the most ambitious structure of its type in the valley. It will have a main arch of 280 ft. and two 90-ft. arches at the ends. The bed of the creek will be 200 ft. below the roadway. A suspension bridge estimated at $140,000 has also been proposed. All other bridges are of slab-and-girder type. One over the mouth of Big Cottonwood Cañon with three beams and slab spans of 20 ft. will be on a radius of 82 ft., the road circling up stream to gain a view of the water-works dam spillway. The roadway is 20 ft. wide and has a superelevation of 8 in. for an assumed speed of 20 miles per hour by the heaviest touring car. The outer girders are deepened to allow for the impact. For two 30-ft. spans

of beam-and-slab construction to be built over the Jordan River in Midvale, shallow beams were necessary on account of 14-ft. head room only above high water. This structure will be 24 ft. wide on five girders and will have cantilever sidewalks.

Of the 73 miles of hard-surface road planned for the county, the county will build 43, and 20¾ miles are under contract. C. F. Hillman, chairman of the county commissioners and commissioner of roads, is the originator of the extensive county system and of the bond-issue method of getting them. George G. Bywater, county surveyor, is also highway engineer in charge of the engineering and the force-account work. The state work is under Ira R. Browning, state highway engineer.

Passenger Train Resistance Tests

EXPERIMENTS on the tractive resistance of passenger trains show that in these, as in freight trains, the resistance measured in pounds per ton decreases as the weight of car increases, so that this unit is lower for trains composed of heavy cars than for those composed of light cars. Regular main-line trains on the Illinois Central R. R. were utilized for the experiments. These trains had from four to 12 cars each, the weight per car ranging from 33½ to 71 tons and the total weight behind the tender ranging from 138 to 727 tons. A report on the observations and results, by Professors Edward C. Schmidt and Harold H. Dunn, is given in Bulletin No. 110 of the Engineering Experiment Station of the University of Illinois.

PASSENGER TRAIN RESISTANCE

Weight of Car or Train	Car Train Resistance: Lb. per Ton Cars 20 Miles per Hour	40 Miles per Hour	60 Miles per Hour
30-ton car	9	11½	14½
40-ton car	6½	8½	11½
50-ton car	5½	7	9½
60-ton car	5½	6½	8½
70-ton car	4½	6	8
Eight 40-ton cars	5½	8½	11
Ten 60-ton cars	4½	6½	8

The influence of car weight upon train resistance has been understood for several years and is recognized generally in the preparation of tonnage ratings for trains. Although a similar influence upon passenger trains has appeared highly probable, this factor has not received much recognition in regard to the latter. The authors of the report consider that this is due partly to lack of experimental data and partly to the fact that the range of weight is much less for passenger cars than for freight cars, so that this factor is of less economic importance for passenger service than for freight service. Thus, the weight of freight cars may range from about 18 to 100 tons while that of passenger cars ordinarily is only from about 35 to 65 tons.

Passenger train resistances for both cars and trains at different speeds are summarized in the accompanying table, which is prepared from diagrams in the report. The observations were made with trains running on stone-ballasted track laid with 85-lb. and 100-lb. rails. Weather conditions were favorable in most cases and wind resistance is included in the final results. It will be seen that as the car weight increases there is a regular reduction in the resistance.

Treatment of Canning-Plant Wastes in Wisconsin

State Board of Health Has Prepared General Plans for Treating Plain Washings, Silage Juice and Combined Wastes

By E. J. Tully

State Sanitary Engineer, State Board of Health, Madison, Wis.

TREATMENT of canning plant wastes is a phase of the industrial waste problem which is of concern not only to state boards of health but to conservation commissions also. The discharge of raw liquors of this type, particularly into relatively small streams, is decidedly toxic to fish life, as we have experienced in a considerable number of instances in Wisconsin.

Three types of water-course pollution or nuisance may result, and usually ensue, from the direct discharge of canning wastes into water; namely, physical, chemical, and bacterial. The latter type is augmented when sewage disposal complicates the industrial waste-problem, as is the case where a public sewer system is not available for the disposal of waste of this character. The wastes discharged include cooling waters, pea washings, floor washings, silage juice, and sewage.

In preparing canning-plant products for "processing," large volumes of water are used to wash the peas, corn, etc., and as a result of such washings a relatively large amount of suspended matters is discharged, part of which is of a gross and part of a fine character. In addition to the washings, large volumes of water are used for cooling purposes, but such water is practically free from foreign substances and may be discharged into the line carrying the treated effluent to the watercourse, thus effectively using it for the dilution of the effluent. Silage juice results from fermentation of the vines, which are usually stacked adjacent to the plant, and during the period of active fermentation the volume of such waste is substantial. This liquor, the product of fermentation, is a relatively concentrated, brown, turbid waste, and decidedly acid in character.

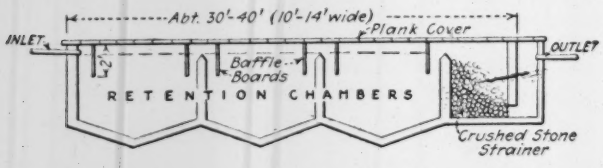
Domestic sewage should always be disposed of by discharge into the public sewer system, where available.

Wash water ranges from ½ to ¾ gal. per can of product. The silage juice discharged per day varies with the amount of vines and the fermentation activity.

When the vines are stacked, rather than placed in a silo, the daily volume may be greatly augmented during periods of rain, a diluted juice resulting under such conditions. The volume of water used for cooling purposes is a factor which is not involved in the treatment problem, as all water used for this purpose should be diverted around the treatment system and used to dilute the effluent.

The wastes to be considered, therefore, include products of washings, silage juice and, under certain conditions, sewage. Briefly stated, treatment of these wastes involves reduction of the concentration of the organic matter, in suspension and in solution, to conform to local sanitary requirements; and the plan indicated to accomplish this end includes diversion of all cooling water around the treatment system to be used to dilute the effluent; coarse screening of the waste products prior to discharge into the system, if it is desired to recover peas, etc., to be used for cattle-feeding purposes; discharge of domestic sewage into public sewer

systems, when such facilities are afforded; conveying pea, corn and plant washing and silage juice effluent, and sewage if necessary, to a common point, and subjecting wastes to treatment in a combination unit comprising a sedimentation or retention unit of three sections and a crushed stone gravity or contact filter, depending on topographical conditions; and preliminary treatment of silage juice, using lime or soda-ash to neutralize partly the acidity and reduce the organic concentration, and subjection of the chemically treated liquor to sedimentation, coke contact or gravity straining and gravel-sand filtration, depending on the degree



RETENTION CHAMBER AND STONE STRAINER FOR TREATMENT OF CANNERY WASHINGS

Sizes of stone for strainer: Bottom, egg; middle, 1-inch; top, ⅜ to ¾ inch.

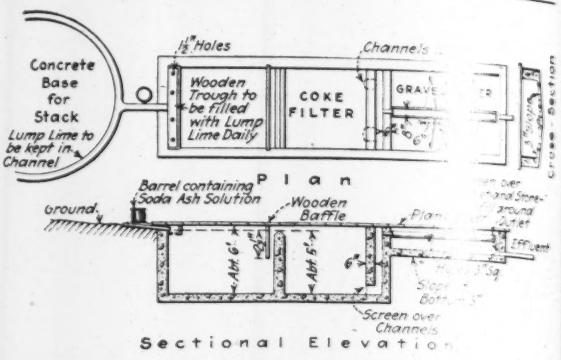
of treatment required prior to the discharge of the effluent into the unit used to treat the washings. When the available stream dilution is small and conditions point to the use of an upper layer of gravel- coarse-sand mixture in the washings' treatment unit, a stone contact strainer is indicated between the retention chambers and the filter. When a watercourse is not available or is relatively distant and a gravel-sand formation is at hand, disposal of the final effluent by natural filtration in a series of excavations is an indicated procedure.

In every instance, local sanitary requirements are the main factors to be considered in deciding on the degree of treatment. The purpose is to effect satisfactory reduction in the concentration of the wastes, and thereby produce an effluent of such character that disposal may be satisfactorily effected either by dilution or ground filtration.

General outlines of plans which have been developed for treatment of canning plant wastes are illustrated in the accompanying illustrations. These plans of treatment afford satisfactory methods of purifying such wastes, provided intelligent operation and care are given the system, including such chemical treatment as is directed, removal of scum and sludge or deposit as often as the conditions indicate the necessity of cleaning, renewal of coke each season, and frequent raking of the surface of the filters.

Fig. 1 illustrates a type of treatment indicated for washings not complicated with silage juice. The crushed stone strainer at the end of the unit may be either of the contact or gravity type, depending on available elevation.

Fig. 2 shows a unit for treating silage juice. The lime or soda ash is applied from a



GENERAL-SCHEME FOR TREATING SILAGE JUICES AT CANNING PLANTS

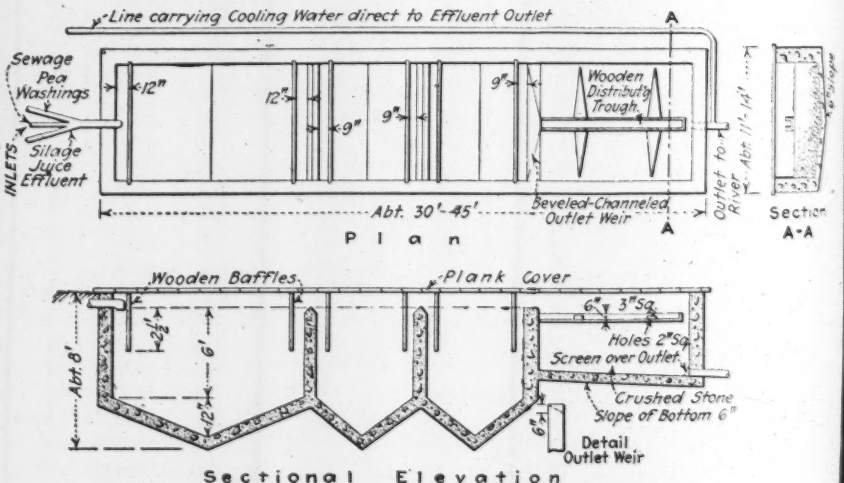
Sizes of coke: Bottom layer, 1-inch; top, ½ to ¾-inch. Sizes of gravel: Bottom, 1-inch; middle, ½ to ¾-inch; top, mixture of gravel and coarse sand

barrel or solution box prior to entrance to the sedimentation chamber. The trough below the inlet acts as a mixing unit and may be also used for liming purposes. The coke strainer may be either of the contact or gravity type, depending on the local conditions prevailing in each case.

Fig. 3 indicates a system for treating combined wastes, washings, silage juice and sewage.

Modifications of these schemes may be employed to accomplish such results as may be required for a particular case. It is pertinent to call attention to the advisability of definitely indicating to the officials of concerns installing works for the treatment of cannery wastes the necessity for proper supervision and operation of such works.

General sanitation with reference to canning plants is a most important matter. To insure clean conditions in and about such plants sanitary regulations have been formulated by the State Board of Health and copies of such regulations have been sent to officials of the canners' association of our state. The association has recently appointed a full-time sanitary inspector who is now coöperating with the state departments in the program which has for its purpose the maintenance of sanitary conditions in and about such canning plants.



SEDIMENTATION AND FILTRATION PLANT FOR COMBINED WASTES FROM CANNING FACTORIES

Sizes of stone for filter: Bottom, 1-inch; middle, 1-inch; top ½ to ¾ inch

Water-Works Operating Problems at Quincy, Illinois

Changed Pumping Conditions Increase Head—Main Cleaned and Gate Repaired—Pressure and Pumping Cost Reduced

By W. R. Gelston
Superintendent of Water-Works, Quincy, Ill.

CLEANING a force main has materially reduced the cost of pumping the water-supply of Quincy, Ill., through a decrease in pressure head and more favorable operating conditions. Incidentally, the cleaning operation discovered a broken gate valve.

Until May 19, 1919, the entire City of Quincy was supplied with water by dumping from the filtration plant, on the Mississippi River, through the distribution system to a storage reservoir 2½ miles distant on the highest hill in the corporate limits. The static head at the pumping station, with the reservoir full, is 90 lb. per square inch. With the pump discharging 4200 gal. per minute it operated against a head of 103 to 110 lb. per square inch, depending upon the rate of consumption.

The capacity of the filtration plant is 6,000,000 gal. per 24 hours, and the pumping station is always operated at the full capacity of the filters. The average daily consumption of water is less than 2,000,000 gal., so eight hours per day is about the average time of pumping. Therefore the static reservoir head prevails throughout the city about two-thirds of the time.

Booster Station and Tank Put In

In recent years the high ground surrounding the reservoir has been built up, and the reservoir pressure there has not been satisfactory. To make the pressure adequate, a booster pumping station and an elevated tank were built on ground adjacent to the reservoir, and about 18 miles, or 23%, of the distribution system was cut off from the reservoir service and placed under the tank pressure. While some increase in the operating head at the river pumping station was expected as a result of this change, the increase was greater than expected and more than some of the mains were designed to withstand. There was only one break in cast-iron mains, however, as a result of the increase in pressure.

A three-stage centrifugal pump is used most of the time, at the river station, for pumping water to the reservoir. Previous to the change in the distribution system, this pump operated under a head of about 106 lb. per square inch when discharging 6,200,000 gal. per day. Since the pump operates at a constant speed, any decrease in the discharge head results in an increase in the amount of water discharged, and vice versa. After the change in the limits of the distribution system, the pressure increased to such an extent that the pump would only discharge from 3,200,000 to 4,800,000 gal. per day, depending upon the amount of water being drawn from the distribution system. At the highest rate of discharge it developed the lowest pressure, about 117 lb. At the lowest rate of discharge the pressure ran as high as 126 lb. per square inch. Since the static pressure at the pumping station is 90 lb., the frictional resistance to be overcome in pumping at a rate equivalent to 55% of the capacity of the plant was 36 lb. or 83 ft.

The force main from the pumping station to the reservoir consists of the following sizes and lengths of pipe: 1320 ft. of 18-in., laid in 1881; 3300, 16, in 1877; 1900, 15½, in 1875; 810, 16, in 1882; 1750, 18, in 1882; and 4720 ft. of 20-in., laid in 1882; total, 13800 ft. There are four depressions in the grade line.

Contract Let For Cleaning the Force Main

Untreated Mississippi River water was pumped through the force main until 1891, when the first filtration plant was built. There was considerable tuberculation in the Quincy distribution system, but it had not been considered serious. It did not seem possible that the tuberculation could be the cause of so much frictional resistance as existed. However, all of the valves on this line and all of those on connecting pipe were tested, and seemed to open and close properly. No accumulation of air could be found at any of the high points, so it was decided that tuberculation and deposits of silt in the depressions were causing the excessive frictional resistance. A contract was then made with the National Water Main Cleaning Co. for cleaning the pipe listed above.

The work was started July 15, 1919, at the pumping station end, and progressed toward the reservoir. Although considerable tuberculation was removed and there was some improvement in operating conditions from the successive machine runs, the results, as a whole, did not promise to give the desired relief, until an opening was made close to a 20-in. valve which was located 2700 ft. from the reservoir end of the line. This valve was a bevel-gear horizontal type of taper-seat double-gate valve. One of the trunnions on the bell of the valve was broken, allowing its gate to remain in the closed position while the other gate was moved back and forth in the normal manner by turning the stem. The broken surface of the trunnion was covered with a thick coat of rust and tuberculation, indicating that the valve was broken many years ago.

Power Consumption Reduced

The removal of this obstruction gave the desired relief. There was still, however, about 2700 ft. of 20-in. pipe to be cleaned, and the results obtained from cleaning it give, approximately, the value of the cleaning operation.

The pump operated one day with the broken gate removed and 2700 ft. of uncleaned pipe. The power consumption, on this run, was 1165 kw.-hr. per 1,000,000 gal. pumped. The average power consumption for 14 similar runs, succeeding the cleaning of the last section, was 1135 kw.-hr. per 1,000,000 gal. This saving of 30 kw.-hr. per 1,000,000 gal. will result in an annual total of $141.75 in power cost alone for the pump on this service. A proportional saving cannot be claimed for the entire line of pipe which was cleaned, because the first 9300 ft. at the pumping station end is a part of the reservoir distribution system and has branches leading from it at nearly every street intersection. The last 4500 ft. of 20-in. main, however, is purely a force main passing through the tank district, and all of the intersection branches were disconnected from it when the tank distribution system was put in service. It can, therefore, safely be assumed that a proportional saving resulted from cleaning 4500 ft. of 20-in. pipe or 2700 ft. : $141.75 : : 4500 ft. : x, or x = $236.25, which is the annual saving of power cost from cleaning 4500 ft. of 20-in. pipe. This sum capitalized at 5%

gives $4725 as the sum which might be reasonably expended in cleaning the 4500 ft. of pipe. As a matter of fact, the cost of cleaning the entire line was considerably less than this amount.

A comparison of the operating conditions since cleaning the mains and removing the broken gate with the conditions during June, previous to beginning the cleaning, shows the following results:

In June the pump discharged from 3,200,000 to 4,800,000 gal. per day with the discharge valve wide open, against pressures ranging from 117 to 126 lb. per square inch, and it was necessary to pump about 13 hours per day to maintain the supply. Since the cleaning was completed, the pump discharges against a partly closed discharge valve all of the time. Controlled in this manner, it discharges from 6,000,000 to 6,750,000 gal. per day against heads ranging from 100 to 104 lb. per square inch on the reservoir side of the partly closed gate. With the rate of discharge reduced to 4,800,000 gal., the maximum under the conditions before cleaning, the pressure drops to 95 lb. per square inch as compared with 117 lb. before cleaning. The plant is now operated only eight hours per day and six days per week.

The power used by the pump on the reservoir service now averages 289 kw.-hr. per 1,000,000 gal. less than the average for June, and there is an additional average saving of 49 kw.-hr. per 1,000,000 gal. from the operation of the pump which lifts the water from the river to the filtration plant, due to the increased rate of discharge. This makes a total saving of 338 kw.-hr. per 1,000,000 gal. pumped. The power is purchased from the local power company at 0.75c. per kilowatt-hour. The saving is therefore $2.54 per 1,000,000 gal. or $1600 per year at the present rate of consumption.

A comparison of the present operating conditions with the condition previous to cutting off the tank distribution system shows that the centrifugal pump has about 10% greater discharge capacity, due to a decrease of about 3 lb. per square inch in the discharge head. In other words, the cleaning of the mains and the removal of the broken gate offset the frictional resistance caused by cutting off the 18 miles of mains and putting in the booster and tank, and made an additional gain of about 3 lb. per square inch in head.

Questions Relating to Effect of Broken Gate

Two questions are suggested by finding the broken gate: (1) How serious has the obstruction caused by the broken gate been in the years which have passed since it was broken? and (2) Why was it not discovered sooner? Both questions are answered by the same explanation.

The effect of the broken gate, previous to cutting off the new distribution system, was practically *nil*. This was due to the fact that (1) practically all of the pumping operations were carried on during the hours of maximum consumption, and at least 50% of the water pumped went direct to the consumers without going to the reservoir at all; (2) there were four 6-in., two 8-in. and one 12-in. connections, with a total area of 326.7 sq.in., carrying water around the broken valve and into the 20-in. main between the valve and the reservoir; (3) the Quincy water-works plant was not equipped with pressure-recording gages until 1911, and the valve was undoubtedly broken before that date; (4) there was a considerable amount of water passing through the broken valve, around the lo[illegible]te and through the hood. This last assertion was [illegible]usively proved during the cleaning operations.

After the new distribution system was [illegible] there remained only two mains carrying water [illegible] reservoir—the 20-in. main which was cleaned [illegible] 21-in. main which also ran through the new dist[illegible]nd connected into the 20-in. main just outside o[illegible] reservoir. When the pumping station was not [illegible]peration all of the water used in the reservoir dis[illegible] had to pass through this 12-in. pipe and the 20-i[illegible]pipe, obstructed as it was with the broken gate. [illegible]n spite of this obstruction, there was no serious drop [illegible] pressure at any time when the pump was not running. While the cleaning operations were under way it became necessary to shut off the 20-in. main in which the broken valve was located. While the main was shut off, the engineer at the pumping station, through a misunderstanding, shut down the plant, and all of the reservoir distribution had to be supplied temporarily through the 12-in. main. In a few minutes the office was besieged with inquiries from consumers who could not get water. The pressure in the office, which is normally about 42 lb. per square inch, dropped to 22 lb. This sudden drop in pressure proves conclusively that a considerable amount of water must have passed through the broken valve and that it was not so serious an obstruction as might be supposed. It was serious, at any rate, only during the period between May 19, 1919, when the tank district was cut off, and the date of its removal, Aug. 5, 1919.

Brittleness in Nickel-Chrome Steel

According to elaborate experiments carried on in England during the war, and reported last month by R. H. Greaves before the Iron and Steel Institute (London), nickel-chrome steel is likely to be made brittle by final slow cooling from a temperature of 600° C. or above, while every tempering treatment that was tried involving a final rapid cooling from above 600° gave good impact figures. Furthermore, steel of satisfactory toughness was always made brittle by reheating to a temperature of about 520° C., or by higher heating when followed by slow cooling. Brittle steel could be restored to toughness by reheating to a temperature between 600° and 670° and cooling rapidly. All these effects are practically without influence on the tensile strength of the material. Other experiments reported by F. Rogers at the same meeting, indicated that the amount of working of nickel-chrome steel affects its susceptibility to "tempering brittleness." The more a steel is worked, the greater is its susceptibility to this effect.

In a separate study of nickel-chrome forgings, carried out by J. H. Andrew, J. M. Greenwood and G. W. Green, the importance of keeping the metal clean and of casting under the right conditions was brought to the fore. One suggestion made for keeping the metal clean is to pour it through ~~a funnel lined with basic material, which~~ would catch much of the included slag in the metal and allow only the pure steel to go through the hole in the bottom of the dish. Ingots should be cast wide end up, and casting should be done at as low a temperature as possible. A high ladle temperature, holding the metal in the ladle, and casting cool, are advantageous features, by giving cleaner metal, keeping the crystals small and preventing ghost lines. Thorough soaking immediately after casting is said to help in promoting soundness and preventing the liability to cracking.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Water as a Natural Resource

HYDROLOGY: The Fundamental Basis of Hydraulic Engineering—By Daniel W. Mead, M.Am. Soc. C.E., Consulting Engineer, Professor Hydraulic and Sanitary Engineering, University of Wisconsin. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth; 6 x 9 in.; pp. 647; illustrated.

REVIEWED BY F. H. NEWELL

Professor of Civil Engineering University of Illinois, Urbana

Professor Mead's "Hydrology" has interest and value to students of the natural resources of the country, particularly those who are concerned with the better conservation and use of water in the production of power and in irrigation, drainage and flood protection.

The material brought together, largely from the results of his own work, covers the occurrence of water, its distribution and fluctuations in quantity—especial attention being given to rainfall phenomena and to the observations of atmospheric conditions which control precipitation. Following this is a discussion of the influence of geology and of topography upon the occurrence of water in the ground and flowing off its surface, with a consideration of the causes and effects of floods, the practicability of water storage and other applications of engineering data. The book, in its wealth of detail, is almost encyclopedic in character. The data are visualized by diagrams and supplemented by copious references to related literature. It forms a valuable and needed introduction to the work of the same author on "Water Power Engineering." It has been preceded by the author's "Notes on Hydrology" issued over a decade ago for the use of his students, but these notes have been so amplified and revised that the present may be considered as a new book.

The ramifications of hydrology, as treated by Professor Mead, illustrate the fact that the successful engineer must be a keen student and observer of natural phenomena, many of which are often considered to lie outside of engineering, such as meteorology, geology, soil physics, forestry and various phases of economics. His discussion of these matters is not only of value to the practicing engineer but the clear way in which the subjects are handled make the facts accessible and really interesting to the general reader.

Forest Products Other Than Lumber

FOREST PRODUCTS, THEIR MANUFACTURE AND USE: Embracing the Principal Commerical Features in the Production, Manufacture, and Utilization of the Most Important Forest Products Other Than Lumber in the United States—By Nelson Courtlandt Brown, B.A., M.F., Professor of Forest Utilization, The New York State College of Forestry, Syracuse, N. Y., etc. New York and London: John Wiley & Sons, Inc. Cloth; 6 x 9 in.; pp. 471; illustrated.

The magnitude of the forest-product industries is well emphasized by the fact that the author speaks of the necessarily brief treatment he has been able to give to each product in a book so large as the present one, from which all consideration of lumber is omitted, as well as such woodworking industries as furniture, shipbuilding and car construction.

After a general introduction, wood pulp and paper, tanning materials, veneers, slack cooperage, naval stores, hardwood distillation, and a variety of other topics are taken up. Chapters of most appeal to readers of *Engineering News-Record* are those on cross-ties, poles and piling, posts, and mine timbers.

The chapter on ties gives the species used and requirements for a good tie, discusses sawed versus hewn ties, deals with specifications and prices, goes into the shaping and delivery of ties to the market, and takes up seasoning, preservation and protection against mechanical wear. The chapter on poles follows somewhat the same general lines and contains a few paragraphs on substitutes for poles and piling. There is a bibliography at the end of each chapter.

Government Work for Irrigation

THE UNITED STATES RECLAMATION SERVICE: Its History, Activities and Organization. Institute for Government Research. New York and London: D. Appleton and Co. Cloth; 6 x 9 in.; pp. 177.

Among its other undertakings, the Institute for Government Research, which describes itself as "an association of citizens for coöperating with public officials in the scientific study of government with a view to promoting efficiency and economy in its operations and advancing the science of administration," has set for itself the task of preparing monographic descriptive studies of each of the fifty or more distinct services attempted by the Government of the United States. These studies follow a uniform plan which is outlined in the volume before us as follows:

"1. The history of the establishment and development of the service; (2) its functions described not in general terms but by detailing specific activities; (3) its organization for the handling of these activities; (4) the character of its plant; (5) the compilation of or reference to the laws and regulations governing its operation; (6) financial statements showing its appropriations, expenditures and other data for a period of years; (7) finally, a full bibliography of the sources of information, official and private, bearing on the service and its operation."

These monographs are descriptive rather than critical. They are designed to be of service to both officials and to those laymen who are interested in the branch of the Government dealt with. The volume on the Reclamation Service does not need specific description, since it conforms with the general plan, already given, for the series. It is written in a direct, attractive style and presents a large amount of information in small compass. The bibliography is quite extensive.

A Keenly Observant World-Roving Engineer

INCIDENTS IN THE LIFE OF A MINING ENGINEER—By E. T. McCarthy A.R.S.M., M.I.M. & M., M.I.M.E., M.Am. I.M.E., F. R. G. S. London: George Routledge and Sons, Ltd.; New York: E. P. Dutton & Co. Cloth; 6 x 9 in.; pp. 384.

Accounts of adventures with and observations on men and nature in what were at the time and in some cases still are out-of-the-way places of the world, make up this entertaining volume. Except as backgrounds, the author's extensive and varied experiences as a mining engineer are not given. The author shows still further restraint by confining his story to the first 18

of his 44 years of life as a mining engineer, stating that he thinks "impressions are much more vivid in early life than in later life."

After some preparatory experience in an English coal mine, and a course at the Royal School of Mines, the author was surprised by an offer to go to a gold mine in North Carolina After two years spent there he resolved to carry out a long-felt desire to go to West Africa, but before leaving America he decided to go west to "collect information, especially with regard to Leadville, the new silver mining camp in Colorado." Some fifty pages are devoted to these early American experiences. These pages contain many interesting observations on both negroes and Indians.

Returning to England, Mr. McCarthy was soon on the West African coast, and later in Morocco. He then went to western Canada, stopping at Calgary when that place was in its veriest infancy, and while it was still uncertain whether the Canadian Pacific Ry. would pass through it. Proceeding by horse he went to Montana, then to Vancouver. In these chapters we have still more about the American Indians and Western pioneer days.

Subsequently the author was for some time in Nicaragua, visiting en route the Panama Canal in the French days. The grossly unsanitary conditions then prevailing and the hopelessness of the project as then conducted are set forth. Still later the author was located in the Malay peninsula and then went to China, Australia and New Zealand. Four chapters are devoted to life in Uruguay and one to the low country of South Africa; with this chapter the book closes.

It is to be hoped that the welcome which is being accorded to this book here and abroad will induce the author to give the world the benefit of his keen observations of men and things during the later years of his professional life.

Our National Parks and Monuments

THE BOOK OF THE NATIONAL PARKS—By Robert Sterling Yard, Chief of the Educational Division, National Park Service, Department of the Interior; Author of "The National Parks Portfolio," "The Top of the Continent," etc. New York: Charles Scribner's Sons. Cloth; 6 x 9 in.; pp. 420; illustrated.

Written with fullness of knowledge and with a large measure of intimate personal acquaintance, this volume promises to fulfil the two principal objects of the author: "The one is to describe and differentiate the national parks in a manner which will enable the reader to appreciate their importance, scope, meaning, beauty, manifold uses and enormous value to individual and nation. The other is to use these parks, in which Nature is writing in large, plain lines the story of America's making, as examples illustrating the several kinds of scenery, and what each kind means in terms of world building."

To carry out this twofold object the descriptions are ordered in four groups: Parks whose geological formation is (1) granitic; (2) volcanic; (3) sedimentary, and (4) the Grand Cañon and national monuments. The book is prefaced by 14 pages "On the Appreciation of Scenery," and each of the main sections has from three to seven introductory pages dealing with the scenery of its type, the fourth and longest section being entitled "On the Scenery of the Southwest."

From a very handy table it appears that our 18 national parks have a total area of 10,739 square miles, ranging from 1½ miles of Hot Springs, in middle Arkansas, to the 3,348 miles of the Yellowstone, in northwestern Wyoming. These are the two earliest parks, created in 1832 and 1872. The latest, established in 1919, is Lafayette Park, on the Maine coast, eight square miles in area. Included in the 18 parks described are Hawaii (1916) and Mount McKinley, Alaska (1917). Among the national monuments described is the Rainbow Bridge, in Utah, discovered in 1909, a natural arch of 209 ft. span and a clear opening 309 ft. high.

Interwoven in each description is a brief account of the efforts, often long and arduous, made to set apart for national use each park or monument. The volume should serve to stimulate interest in the great system of national parks and monuments being established and made accessible to all by our national Government.

Orifices in Pipe

THE ORIFICE AS A MEANS OF MEASURING FLOW OF Water Through a Pipe—By Raymond E. Davis, Associate in Civil Engineering, and Harvey H. Jordan, Assistant Professor in General Engineering Drawing, University of Illinois, Urbana: Engineering Experiment Station. Paper; 6 x 9 in.; pp. 56; illustrated.

Definite coefficients have been obtained by experiment by the authors on the measurement of the flow of water through 4- to 20-in. pipes by means of a thin-plate circular orifice. The device is applicable, in the author's opinion, to testing pump efficiency; individual wells in a water-works system; water consumption for individual purposes in mills and factories; discharge in city mains, and measuring irrigation water.

Tests were made to determine: (1) The position of two cross-sections of the pipe, one section upstream from the orifice, the other downstream from the orifice, at which pressure head may be measured and the drop in pressure from one section to the other may be most favorably determined; (2) the relation between this drop in pressure head and the rate of discharge through the pipe; (3) the lost head occasioned by the orifice; (4) the effect of small deviations from what may be termed standard conditions, and (5) the proper size of orifice for given conditions.

Chemical Reference Book for General Use

THE CONDENSED CHEMICAL DICTIONARY: A Reference Volume for All Requiring Quick Access to a Large Amount of Essential Data Regarding Chemicals, and Other Substances Used in Manufacturing and Laboratory Work—Compiled and Edited by the Editorial Staff of the Chemical Engineering Catalog. F. M. Turner, Jr., Technical Editor; Assistant Editors, D. D. Berolzheimer, W. P. Cutter, John Hoffrich. New York: The Chemical Catalog Co., Inc. Cloth; 6 x 9 in.; pp. 525.

Designed primarily for the increasing number of persons without chemical training who have frequent need for a handy dictionary of chemical and allied substances, the editors express what appears to be a well founded hope that this volume will be a time-saver for chemists also. Besides the dictionary proper, the book contains a number of pages devoted to combining (atomic) weights, domestic weights and measures, metrical equivalents, conversion tables, definitions of units, and extracts from regulations governing the transportation of explosives and other dangerous articles by freight and express. The dictionary gives for each substance listed its chemical symbol, color and properties, chief constituents, constants, solvents, derivation, method of purification, container, uses, fire hazard and shipping regulations. Space is left between the entries, and also by means of liberal margins, for supplementary notes. The dictionary promises to be widely useful.

For the Average Health Officer

THE HEALTH OFFICER—By Frank Overton, A.M., M.D., D.P.H., Sanitary Supervisor, New York State Department of Health, and Willard J. Denno, A. B., M. D., D. P. H., Medical Director of the Standard Oil Company, Formerly Secretary of New York State Department of Health. Philadelphia and London: W. B. Saunders Co. Cloth; 6 x 9 in.; pp. 512; illustrated.

Except for having a horizon restricted to New York State in matters of statutory powers and Governmental administrative details, the authors have produced a volume that bids fair to meet their aim to tell the "average" health officer "what to do, how to do it and why he should do it." Particularly commendable is their recognition of the fact that the province of the health officer is to deal with man in his relation to public health, leaving to the sanitary engineer the satisfaction and safeguarding of most of his physical wants and comforts affecting health more or less directly, such as nuisances, plumbing, garbage disposal, water-supply, sewerage, water purification and sewage treatment. The authors might well have gone somewhat further in this respect and either have attempted less or used more care in their treatment of some sanitary-engineering subjects. This is particularly true of sewage disposal, which is the stumbling block over which nearly every medically trained writer on health and sanitation falls.

PUBLICATIONS RECEIVED

Under a Postoffice Department ruling made applicable to *Engineering News-Record* in July, 1919, it is no longer possible to give the prices of new publications announced under this head or of books reviewed in the preceding columns. Readers will therefore have to obtain this information as best they can. Most of the public documents and of the pamphlets announced may be obtained free on application, or at least by paying postage. So far as possible, the name and address of the publisher of each book and pamphlet are given in each entry.

THE AGRICULTURAL AND INDUSTRIAL COMMUNITY FOR Arrested Cases of Tuberculosis and Their Families: A Study. 1919. Washington, D. C.: Federal Board for Vocational Education. Paper; 6 x 9 in.; pp. 45.

Combined agricultural and industrial communities resembling English garden cities are proposed. Private funds would be put in the hands of trustees who would provide land, buildings and industrial plants and organize an executive staff with departments similar to those under the commission plan of city government. The pamphlet was proposed by H. A. Pattison, field secretary of the National Tuberculosis Association.

BLUEPRINTING—By John F. Friese, Editorial Assistant and Draftsman, Manual Training Magazine. Peoria, Ill.: The Author. Cloth; 5 x 7 in.; pp. 56; illustrated.

BUILDING ORDINANCE—Chicago, Ill.: National Lumber Manufacturers Association. Cloth; 5 x 8 in.; pp. 60; illustrated.

CHIEF OF ENGINEERS: Report of United States Army, Three Parts, 1919. Washington, D. C.: War Department. Paper; 6 x 9 in.; illustrated. Part I, Annual Report of the Chief of Engineers, pp. 2107. Part II, Report of the Board of Engineers for Rivers and Harbors and Reports of District Engineers, pp. 1262. Part III, Report of District Engineers, pp. 1118.

CLAYS AND SHALES OF MINNESOTA—By Frank F. Grout; with Contributions by E. K. Soper. Work done in Coöperation with the Minesota Geological Survey. Washington, D. C.: U. S. Geological Survey. Paper; 6 x 9 in.; pp. 259; illustrated. 25c. from Superintendent of Documents.

A COMPARISON OF THE HEAT INSULATING PROPERTIES of Some of the Materials Used in Fire-Resistive Construction—By Walter A. Hull, Associate Physicist, Bureau of Standards. Washington, D. C.: The Bureau. Paper; 7 x 10 in.; pp. 40; illustrated. 10c. from Superintendent of Documents.

ELECTROLYSIS IN CONCRETE—By E. B. Rosa, Chief Physicist, Burton McCollum, Associate Physicist, and O. S. Peters, Assistant Physicist, Bureau of Standards. Washington, D. C.: The Bureau. Paper; 7 x 10 in.; pp. 142: illustrated. 35c. from Superintendent of Documents.

A second edition of a bulletin published in 1913 containing some additional long-time tests at low voltages, but few new conclusions as to the general problem.

ENGINEERING SOCIETY OF WISCONSIN (INCORPORATED): Report, 1919. Madison, Wis.: The Society. Paper; 6 x 9 in.; pp. 104.

FAR EASTERN MARKETS FOR RAILWAY MATERIALS, Equipment, and Supplies—By Frank Rhea Trade Commissioner. Special Agent Series—No. 180. Washington, D. C.: Bureau of Foreign and Domestic Commerce. Paper; 6 x 9 in.; pp. 259; illustrated. 35c. from Superintendent of Documents.

FIRE DEPARTMENT MOTOR APPARATUS INSTRUCTION: A Complete Technical Description in Firemanic Language, as Officially Taught in the New York Fire Department Automobile School—By Captain Daniel A. Sullivan, Recently, and for Six Years, Instructor of the New York Fire Department Automobile School. New York: Civil Service Chronicle. Paper; 7 x 10 in.; pp. 93; illustrated.

FOREIGN COMMERCE AND NAVIGATION OF THE UNITED States: Report, July-Dec., 1918. Washington, D. C.: Bureau of Foreign and Domestic Commerce. Cloth; 9 x 12 in.; pp. 635. $1.25 from Superintendent of Documents.

INDUCTIVE INTERFERENCE BETWEEN ELECTRIC POWER and Communication Circuits: Selected Technical Reports with Preliminary and Final Reports of the Joint Committee on Inductive Interference and Commission's General Order for Prevention or Mitigation of Such Interference. San Francisco, Calif.: Railroad Commission of the State of California. Leather; 9¼ x 6¼ in. Printed on bible paper; pp. 1160; illustrated.

Gives the results of five years' field and laboratory investigations of power circuit interference with telephone and telegraph lines. The studies were made jointly by engineers representing railway, electrical, telephone and telegraph companies and the California Railroad Commission, at a cost of $100,000. Of the 1200 copies printed subscriptions for 800 have been received. The price has been fixed at cost.

THE INDUSTRIAL BUILDING BOOK—Compiled by Charles F. Dingman, Assoc. M. Am. Soc. C. E. New York: Flynt Building and Construction Co. Cloth; 7 x 9 in.; pp. 69; illustrated.

IOWA ENGINEERING SOCIETY: Proceedings of the Thirty-First Annual Meeting, Feb. 19-20, 1919. Iowa City, Iowa: The Society. Paper; 6 x 9 in.; pp. 212; illustrated.

IRON BACTERIA—By David Ellis, D.Sc., Ph.D., F.R.S.E., Royal Technical College, Glasgow. London, Eng.: Methuen & Co., Ltd. Cloth; 6 x 9 in.; pp. 176; illustrated.

LA LUTTE CONTRE LA ROUILLE ET LES CORROSIONS Dans Les Chaudières à Vapeur—By E. Hoehn, Ingenieur en Chef de L'Association Suisse de Proprietaires de Chaudières à Vapeur. Zurich, Switzerland: The Association. Paper; 6 x 9 in.; pp. 68; illustrated.

MASSACHUSETTS HIGHWAY COMMISSION: Report, 1918. Boston, Mass.: The Commission. Cloth; 6 x 9 in.; pp. 186; illustrated.

MOUNTAIN HIGHWAYS OF HAMILTON, ONTARIO, CANADA: Report, 1919—By N. Cauchon, Consulting Engineer and Town Planner, Ottawa, Can.: The Author. Paper; 11 x 9 in.; pp. 12; illustrated.

NEW YORK PUBLIC SERVICE COMMISSION: Report, 1917—Abstracts of Reports of Corporations, Electrical, Gas, Steam, Telegraph, Telephone. Albany, N. Y.: The Commission. Cloth; 9 x 12 in.; pp. 338.

THE PANAMA CANAL: Report of the Governor, for the Fiscal Year Ended June, 1919. Washington, D. C.: War Department. Paper; 6 x 9 in.; pp. 366; illustrated.

PROGRESS REPORT OF RUN-OFF INVESTIGATION ON Third Creek, Iredell County, North Carolina—By H. M. Lynde, Senior Drainage Engineer, U. S. Dept. of Agriculture. Washington, D. C.: The Department. Paper; 6 x 9 in.; pp. 16; illustrated.

PROPOSED BUILDING ZONES FOR NEWARK: Tentative Report of the Commission on Building Districts and Restrictions, Sept., 1919. Newark, N. J.: The Commission. Paper; 7 x 10 in.; pp. 44; folding maps.

A PUBLIC-BUILDING GROUP PLAN FOR ST. LOUIS—By Harland Bartholomew, Engineer, the City Plan Commission. St. Louis, Mo.: The Author. Paper; 8 x 11 in.; pp. 15; illustrated.

PULVERIZED FUEL: Its Use and Possibilities—By William J. Dick, M.Sc. Ottawa, Can.: Commission of Conservation. Paper; 7 x 10 in.; pp. 57; illustrated.

PURIFICATION OF SEWAGE AND WATER: Experiments at the Lawrence Experiment Station, 1917—By H. W. Clark. Reprinted from the Third Annual Report of the Massachusetts State Department of Health. Lawrence, Mass.: The Station. Paper; 6 x 9 in.; pp. 53; illustrated.

THE QUEBEC BRIDGE—Papers Presented to the Engineering Institute of Canada in 1917, 1918 and 1919. Vol. XXXII, Part I, Transactions (as above), 1919. Paper; 6 x 9 in.; pp. 311; illustrated. Also a 9 x 12-in. paper-bound volume of 117 folding plates. Montreal, P. Q.: Engineering Institute of Canada.

THE QUEBEC STREAMS COMMISSION: Report, 1918. Quebec, Can.: The Commission. Paper; 7 x 10 in.; pp. 120; illustrated.

SOME TESTS OF LIGHT ALUMINUM CASTING ALLOYS—The Effect of Heat Treatment—By P. D. Merica, Physicist, and C. P. Karr, Associate Physicist, Bureau of Standards. Washington, D. C.: The Bureau. Paper; 7 x 10 in.; pp. 31; illustrated. 10c. from Superintendent of Documents.

STATISTICS OF RAILWAYS IN THE UNITED STATES: Report, 1916—Prepared by the Division of Statistics. Washington, D. C.: Interstate Commerce Commission. Cloth; 9 x 12 in.; pp. 959.

THE TESTING OF ANEROID BAROMETERS AT THE LABORatory of the Dominion Lands Surveys. Ottawa, Can.: Dept. of the Interior. Paper; 7 x 10 in.; pp. 9; illustrated.

THE TESTING OF TIMEPIECES AT THE LABORATORY OF the Dominion Land Surveys. Ottawa, Can.: Dept. of the Interior. Paper; 7 x 10 in.; pp. 16; illustrated.

TESTS OF FLEXIBLE GAS TUBING—By R. S. McBride, Engineer Chemist, and Walter M. Berry, Associate Gas Engineer; With a Report on Gas-Tubing Inspection in Newark, N. J. by Ellsworth Francisco, Inspector of Gas and Gas Meters, Newark, N. J. Washington, D. C.: Bureau of Standards. Paper; 7 x 10 in.; pp. 37; illustrated. 10c. from Superintendent of Documents.

UNITED STATES COUNCIL OF NATIONAL DEFENSE: Report, for the Fiscal Year Ended June, 1919. Washington, D. C.: War Department. Paper; 6 x 9 in.; pp. 160; illustrated.

WATER STORAGE AND THE WATER CODE—By G. E. P. Smith, Irrigation Engineer. Tuscon, Ariz.: University of Arizona, College of Agriculture. Paper; 6 x 9 in.; pp. 7; illustrated.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

In Union—Not Confederacy—Lies Future Strength of Engineering Profession

Sir—I have just reviewed the report on development, of the Joint Conference Committee of the four founder societies, and whereas I fully recognize the delicacy of discussing a society action outside of its proceedings, yet in view of the tremendous importance of the subject and the further consideration that the proposed organization affects all engineers irrespective of their membership in the founder societies, I feel more than justified in asking you to bring this matter to the attention of your readers.

The committee is to be congratulated for its recognition of the need for an effective, all-inclusive organization of professional engineers, irrespective of their technical classification, to handle matters of common interest to the entire profession. But against the proposed system of organization I must enter a vigorous protest.

The type of the proposed organization, which the committee did not see fit to name, may be styled "The Engineering Confederacy." The very proposal to form a confede acy is an admission of inability to form a real union. In union—organic union—there is strength, but a confederacy is a makeshift, it is but a delusory substitute for a real union, it can be held together only by exceptional circumstances, it cannot live a normal life, it thrives on excitement and confusion, it can be easily created, because its constituents are not called upon to give up anything, and still more easily dissolved when the time for sacrifice and action arises. We have only to review the political history of the world to see the weak character of the confederation as a type of political organization. There is not an example of a single powerful one that has endured, though many have been formed. We have had two experiments of this character in America.

Now, why do confederations as a means of organization always fail?

1. They are usually brought into existence as the dying struggle of the elements of reaction, to protect vested interests or class prestige that feels itself slipping, losing ground against the overwhelming tide of progress. For there is no need of the confederation where justice rules or common interests prevail; in these premises an organic union is always possible.

2. The constituent members of the confederacy are large and possess a more coherent organic structure, rendering their withdrawal easy on the slightest pretext, thereby disrupting the organization. Moreover, the jealousies of these groups for power and control over the confederacy lead to the formation of wheels within wheels and thus to its ultimate destruction.

3. There is no organic structure to them, they have not the functions of life in them, they have the form but no life, they are a number of lives compressed into a close space without the necessary articulation for developing a single new life apart from the constituent members, there is no *corpus* and their contact is too close to permit individual development. Thus they hinder the individual growth of the constituents and are incapable of life and growth themselves.

4. But the ultimate reason of all the reasons is that they are inefficient, they do not fill the common interests they are designed to serve, they do not survive because only the fittest, the most efficient, forms survive.

We have even tried the confederacy as a type of engineering organization, and it has signally failed to enlist the support and coöperation of engineers. Why rehabilitate a device that always fails? To quote the language of Dr. F. H. Newell in his recent address on coöperation:

We have worked through and beyond this idea of forming small societies of civil engineers and of mechanical engineers and so on with the idea of then getting them to work together, and somehow out of that same combination produce a powerful organization. This idea does not work under present economic conditions. For efficiency we must have an organization in which every man is a member just as much as he is a citizen of the United States. That does not prevent his being an active citizen or member of his technical society, any more than your citizenship in the United States prevents you from being a good citizen of Ohio or of Columbus. In fact, it strengthens it; but the two citizenships are independent and function without any interference with each other.

This not only disposes of the confederacy type of organization as an effective instrument, but points the way to constructive criticism in outlining a type of organization that will meet our necessities. First let us state the objects to be attained. These are well expressed in the following language from the committee's report:

It was the unanimous opinion of those present at all conferences that one of the most important matters on which joint action can be taken is the formation of a single comprehensive organization to secure united action of the engineering and allied technical professions in matters of common interest to them. . . .

The great object is to provide an effective body, widely and truly representative, modestly yet adequately financed, which will be neither autocratic nor aristocratic, which will at all times stand as the representative and defender of the profession in matters affecting its honor, welfare and common interest. . . .

In submitting the proposed fundamentals to govern a single comprehensive organization by which the engineering and allied technical professions may become more active in their service to the public and themselves, the Joint Conference Committee would point out the following as among some of the objects to be attained by such an organization:

1. To render the maximum of service to the nation through unity of action.
2. To give the engineers of the country a more potent voice in public affairs.
3. To secure greater recognition of the services of the engineer, and to provide for his advancement.
4. To promote *esprit de corps* among the members of the profession.
5. To provide the machinery for prompt and united action on matters affecting the profession, among which are:

Licensing and registration of engineers;
National Service Committee;
National Department of Public Works;
Conservation of national resources;
Publicity;
Classification and compensation of engineers;
General employment bureau;
Engineering education;
International affiliation of engineers;
Industrial relations.

Now, in spite of the fact that the committee has made an excellent summary of the objects to be attained, it is the apparent sense of the committee—in fact, it is the general tenor of that whole portion of

the report on organization—that the maintenance of the prestige of the founder societies is the principal object sought, rather than the creation of an effective organization to consummate the declared objects. The following extract from the report shows specifically that the matter of preserving the prestige of the founder societies was a paramount consideration:

The committee submits the plan with the confident belief that it will be accepted by the four societies, that they will make the sacrifices necessary and assume the responsibility of leadership, supporting the movement by virtue of their position in the engineering profession. A national movement by local societies is sure to come. The four national societies can take the initiative and continue their leadership in American engineering by prompt action, or by inaction lose the prestige they now hold.

Let us not think of preserving the prestige of existing technical organizations, let us not mar the birth of a new spirit in engineering by the dominating shadow of existing institutions, for prestige always goes where it belongs—to those who earn it—and all the mad delirium of precipitate action, after years of inaction, cannot change it. Let us rather think of the form or organization suited to our needs and create it out of men, not out of organizations. Let us build up an organic union of professional engineers and secure their unswerving allegiance.

With this type of organization, group control will be at a minimum. Moreover, it will enlist the support of that great body of engineers who have never been attracted to the existing technical organizations and will thus build up a representative body of engineers who can direct all of their efforts toward the common welfare of the engineering profession and of the public.

To avoid any possibility of misunderstanding the sense in which the word "union" is used in this letter, I desire to state that it is used in the same sense that we speak of the union of the American people or of the union of marriage—that which blends the life of several persons into one for coöperative effort and still preserves the individuality of the constituent persons. It has no reference whatever to the type of organization known as a labor union or trade union.

Chattanooga, Tenn. HENRY B. SMITH,
Civil Engineer.

Cost of Employment Service

SIR—At the annual meeting of the American Society of Mechanical Engineers the secretary of the society, C. W. Rice, is reported to have said in an official statement to the meeting that in three months the employment service of the American Association of Engineers cost $40,000 to operate, and placed about 270 men, while the engineering societies' employment bureau placed about 375 men at a cost of $3750. This statement is ridiculously incorrect. Since the American Association of Engineers was organized there has never been available $40,000 for all its work in any three-month period. The total expense of its service department during the three months of September, October, and November, 1919, was less than $2000.

In our present system for promptly placing employers in touch with qualified men, installed July 1, 1919, difficulty was experienced at first due to failure of engineers to report to us when they accepted positions. At first we received this information from only about 50% of the men. As our members are now more familiar with the new system we are receiving reports on positions introduced from about 80% of the men. In an advertisement in *Engineering News-Record* of Oct. 16, 1919, we made the following statement as a report for the three months immediately after the new system was in operation, namely, July, August and September, 1919:

Positions received 1085
Positions filled by members 264

As the figure given for number of positions filled was based entirely upon the actual number of reports received, which was only about 50% of the number introduced, the actual number of men placed in positions is much greater.

A healthy growth is manifested by the actual number of reports received during the past three months which shows: Positions filled by members for

September 120
October 124
November 145

Total for three months 389

This covers the actual number of reports received of positions filled, and should be increased by about 20% to obtain the actual number of men placed.

The average monthly expenses incurred in maintaining the service department under the present plan of operation, including salaries, advertising in the technical press and the *Professional Engineer* (formerly *The Monad*), postage, stock and printing, rent, telephone, light, and current depreciation of equipment, amount to $575. In three months this totals $1725. Adding $175 as a wide margin for miscellaneous expenses makes the amount $1900, which averages less than $5 for every man placed.

These are the records of accomplishment at national headquarters only. They do not include the number of men placed by the five district offices or through our ninety branches. By adding the reports of the employment committees of the many chapters to the above statement the number of men placed and the benefits received by individual members would be shown to be far greater.

Chicago, Ill. E. B. MILLER,
Assistant Secretary in Charge of Service Department, American Association of Engineers.

[Because of the direct question of fact raised by the above letter we reproduce below, verbatim, Mr. Rice's statement at the annual meeting of the American Society of Mechanical Engineers.—EDITOR.]

THE SECRETARY: Inasmuch as the secretary of your society is the chairman of the joint committee of all the societies operating the employment bureau, I should advise you for your information of the extraordinary work which your society in splendid coöperation with all the societies is doing. In a recent publication of the American Association of Engineers they stated that during the last three months they had been notified of 1000 positions which were vacant, that they had recommended to these positions about 3000, and had placed in positions 271. So that you may know that we are not failing to do our duty, I will report that we have received about the same number, namely 1000 notices of vacancies to be filled; we have nominated 6000 men for these places, and have placed 374.

The expense of the American Association of Engineers in their activities, which, according to their own statement, is primarily if not exclusively that of welfare work and of getting positions, was, according to their published state-

ment, upward of $40,000 during the last three months. They have placed, with an expenditure of $40,000, 271 men in positions. Your Joint Bureau was maintained at an expense of $3750 during the last three months, and has placed 371 men in positions. In other words, it took $40,000 by the American Association of Engineers to canvass and place 271 men, and it took $3750 under our auspices to canvass and place 374 men.

Further Data on the Direct-Oxidation Process of Sewage Treatment

Sir—The tests of the Landreth electrolytic or "direct-oxidation" process for treating sewage made by the State Department of Health of Pennsylvania at Easton and described in *Engineering News-Record* of Sept., 18, 1919, p. 569, appear to confirm in a general way the results of tests made by the Bureau of Sewer Plan of New York City at Elmhurst, Borough of Queens, (*Engineering News* of July 13, 1916, p. 91.)

A summary of the results just mentioned, which have not been published heretofore, is given in the Table I. They were submitted to Prof. E. B. Phelps of the United States Public Health Service for review, and in a letter to the chief engineer of the Board of Estimate and Apportionment he summarizes his conclusions as follows:

TABLE I. SUMMARY OF ELMHURST LIME-ELECTROLYTIC SEWAGE TREATMENT TESTS

(Parts per million except as otherwise noted)

Tests made on sewage received in three hours at the rate of about 0.75 m.g.d. with 4½ hours' retention

Test No.	1	2	3	4
Date, 1915	Dec. 10	Dec. 15	Dec. 21	Dec. 23
Conditions of test	Normal Operation	Normal Operation but Without Electricity		No Electricity Excess Lime
Suspended solids:				
Raw sewage	60	60	88	60
Tank influent	352	216	296	312
Tank effluent	56	52	84	56
Permanganate consumed:				
Raw sewage	42	30	56	32
Tank influent	24	24	62	32
Tank effluent	18	26	44	28
Nitrites:				
Raw sewage	0.900	2.000	0.700	0.260
Tank influent	0.180	2.000	0.900	0.260
Tank effluent	0.180	2.000	0.300	0.260
Nitrates:				
Raw sewage	0.006	1.80	1.20	1.60
Tank influent	1.00	1.80	1.20	1.60
Tank effluent	1.00	1.80	1.20	1.60
Iron:				
Raw Sewage	1.00	1.20	1.20	1.80
Tank influent	4.00	1.00	1.20	1.80
Tank effluent	0.40	1.40	0.60	0.60
Alkalinity:				
Tank influent	306	276	324	344
Tank effluent	260	228	266	274
Causticity:				
Tank influent	190	124	288	176
Tank effluent	132	60	78	46
*Oxygen Demand 0.37° C. 5 days				
Raw sewage	36	32	58	43
Tank influent	36	36	42	40
Tank effluent	16*	15**	24†	12††
Bacteria per c.c.:				
Raw sewage	1,100,000	1,300,000	1,000,000	1,000,000
Tank effluent	4,000	32,000	15,000	15,000
Tank effluent, 4 da.	4 da. 20,000	5 da. 90,000	9 da. 12,000	5 da. 14,000
Tank effluent, 10 da.	10 da. 20,000	8 da. 40,000	.....	12 da. 7,000
Lime (CaO) used, pound per million gallons	670	730	650	1,160

NOTE—With current averaging 28.3 amp., the iron electrodes were estimated to be consumed at a rate of 1.2 oz. per hour.

* Sludge and tank effluent stable, but with alkalinity neutralized this putresced in two days at 37° C.

** Sludge stable. Effluent putresced in five days.

† Sludge stable. Effluent putresced in two days.

†† Sludge stable. Effluent putresced in four days.

1. The character of the final effluent of the Landreth electrolytic process, as demonstrated at Elmhurst, is highly satisfactory.

2. The method of sludge disposal, as employed at Elmhurst, is not satisfactory and could not be employed in any situation where there was real necessity for sewage purification.

3. There is at least a basis for an honest difference of opinion as to whether or not the electrolytic feature contributes materially to the result, opinion upon this matter being about equally divided among those who have properly investigated it.

4. The cost of treatment by this process is so large that it cannot compete under usual conditions with better known treatment processes capable of producing an equivalent result.

To my mind, the high cost of the process is the dominating consideration and in my opinion, founded on the appearance of the effluent and on the condition of the ditch into which both sludge and effluent were discharged, the electrolytic feature is to a certain extent really beneficial in producing a clearer and more nearly sterile effluent. According to Professor Phelps it is analytically "between the effluent of a first-class trickling filter with post-sedimentation and the effluent of a slow sand filter." But a point likely to be overlooked is the fact that the organic matter remains subject to subsequent decomposition and is therefore potential as a future source of nuisance. "All that can be justly said of the treatment is that it is a reasonably effective method, disregarding cost, of separating a large part of the putrescible organic matter from the liquid, and of reducing the bacterial content of both sludge and liquid. . . . If the process is to be of any value in sewage treatment, provision must be made for the disposal of the recovered sludge."

TABLE II. COST OF LIME-ELECTROLYTIC SEWAGE TREATMENT COMPARED WITH OTHER METHODS

Capital Cost Based on 1.5 m.g.d.

Two electro-chemico units, 0.75 m.g.d. each	$32,000
Sludge press to handle 26 cu.yd. daily	13,050
Total	$45,050
Annual Charges Based on 1 m.g.d.	
Electric current 78,475 kw.-hr. at 4c.	$3,139
Lime—237½ tons at $7.90	1,874
Sludge pressing and disposal, 365 days at $5.11	1,865
Pumping	1,925
Supplies	500
Labor, superintendent, two assistants, one laborer and chemist (part time)	5,700
	$15,003
Fixed charges at 5%	2,252
Total per annum	$17,255
Total per million gallons	$47.30

Comparative estimates of different processes were than made for the Elmhurst situation, resulting as follows:

	Capital Cost	Annual Charges	Per Million Gallons
Electro-chemico process	$45,050	$17,255	$47.30
Chemical precipitation	13,550	11,635	32.40
Tanks and trickling filters	34,500	8,650	23.70
Tanks and contact beds	73,600	11,380	31.20
Activated sludge	15,500	12,825	35.10
Acidulation	7,000	11,565	30.00

Based upon the above tests, the cost of a plant having a capacity of 1,500,000 gal. per day and the cost of treating a mean flow of 1,000,000 gal. per day was as shown by Table II.

These estimates, it should be recalled, are for a weak sewage and are based on much lower prices than obtain today.

Plans adopted since then call for the ultimate abandonment of the Elmhurst disposal plant, pumping the sewage to a temporary outlet south of Riker's Island.

KENNETH ALLEN,
Sanitary Engineer, Board of Estimate and Apportionment, New York City.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Safety Suggestions for the Builder

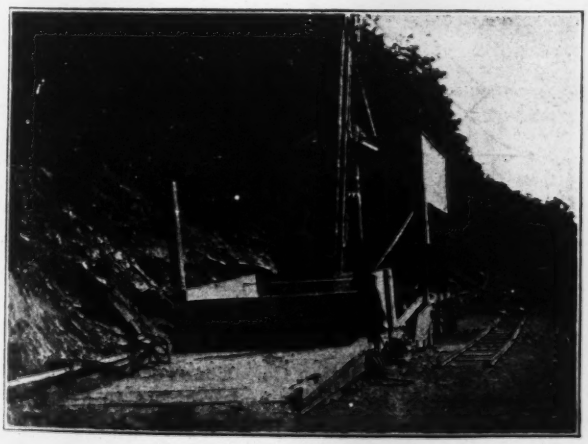
INCLUDED in a recent paper read before the National Safety Congress in its Cleveland sessions by George A. Rutherford, of the George A. Rutherford Company, Cleveland, were several suggestions concerning accident prevention in building work. As insurance measures against accidents, Mr. Rutherford recommended the following:

1. Personal education among employees in safety rules.
2. Periodical inspection of appliances used daily.
3. Insistence on the part of the contractor or superintendent that all jobs be kept free of débris.
4. Making compulsory the fencing in of all floor openings, and the toe boarding of scaffolding where bricklayers and masons are working.
5. Advertisement by safety-first signs, and the inclusion of safety-first propaganda in pay envelopes.

Mr. Rutherford also suggested that a group of employers whose work does not permit the establishment of well organized safety departments, such as are possible in stabilized industries, employ a safety engineer to make periodical inspections insisting upon well known methods of insuring maximum safety.

Motor-Truck Skip and Small Bin Protect Subgrade

PROTECTING the finished subgrade by the use of a short stretch of industrial railway, in connection with a motor-truck skip and elevator bin, has been tried out on work done under the Pennsylvania Highway Department. While the plant accomplishes the intended



ARRANGEMENT OF MOTOR-TRUCK SKIP, MATERIAL BIN AND INDUSTRIAL CARS

purpose in fairly level country, it is unworkable where the grades are steep, as the cars on so short a line are necessarily horse-drawn. The bin and skip are arranged to be easily moved, and by their use all labor of shoveling and wheeling from the subgrade to the mixer is eliminated.

An ordinary commerial elevator bin is used. It is divided into two compartments, one for sand and one for stone. The capacity of the bin is two truckloads of sand and one truckload of stone. The bin is on wheels and is jacked up while in use. The construction of the skip may be seen in the views. It is also

VIEW SHOWING DETAILS OF MOTOR-TRUCK SKIP

on wheels and has an incline on one end, up which the trucks are backed. This incline is raised by means of the block and tackle on the posts at either side, when it is desired to move.

The operation of the plant requires three men in addition to those on the industrial cars and trucks. The trucks dump into the skip, and one man attends to its free flow into the elevator, a second runs the engine and operates the chute into the bin so that it dumps into the sand or stone compartment as desired, while a third fills the compartment batch-measuring boxes on the industrial cars. Enough industrial track is used to allow for from three to four days' run, and the moving of the outfit requires from six to eight hours.

The method is being used by the Quinlan-Robertson Company, Montreal, on route No. 141 in Berks and Schuylkill Counties. The company has found it impracticable on grades of over 6%. The work is being done under the general supervision of W. D. Uhler, chief engineer of the State Highway Department. W. R. Wolfinger, district engineer, is in charge.

Building Association Stock Provides Plant-Replacement Fund

BY O. H. YEAGER
Yeager & Sons Builders, Danville, Ill.

PLANT-rental or equipment charges on construction have for a number of years been so managed by the writer's firm as to eliminate largely the necessity for charging off depreciation.

By a careful system of cost accounting, the firm has

determined the life of standard construction equipment under ordinary use, and the amount spent for maintenance and repairs. For example, take a hoisting engine for which $1200 was paid. It has been found that, with good care, this machine can be used for five years before being salvaged either because of wearing out or replacement with more modern equipment; also, that during that time there has been spent approximately 33⅓ per cent for maintenance and repair. At the end of the five years, therefore, there would have been spent $1600 for the engine. To this add interest at the rate of 7%, and the total is $1712.

During this period of five years it has been found that this machine will work approximately two-thirds of the time, or 1000 working days. This would make an approximate charge of $1.75 per day on the actual investment. This machine must also take care of its proportion of the charge for the maintaining of an equipment repair lot and sheds, insurance and taxes, and pay for the oil, waste and packing which are used, so the charge is increased to $3 a day. All freight hauling, engineer's time and fuel will be charged in addition to this amount.

All money received for equipment rental is carried in a separate account, from which the cost of all of the above items is paid. When a piece of equipment is purchased, an equivalent amount of stock is taken out of a building and loan association, and the dues are paid monthly. This stock generally pays 7%, and a certain amount of it is maturing each year. When a piece of machinery is salvaged, it is found that enough has been paid to the building association, for this particular piece of equipment, to replace it. This method is used instead of a sinking fund, or charging off a certain amount to depreciation.

Small hand tools such as shovels and picks are charged in full direct to the job on which they are being used. The prices of wire cable and of rope have been worked out on a lineal-foot basis. By this system, the rental can be applied on the purchase price.

A card system with a complete description of each piece of equipment is kept from the time it is purchased until it is disposed of. Small tools are lumped. For example, one card is kept for shovels, another one for picks, and so on.

Construction Railway Fill Made by Caterpillar Steam Shovel

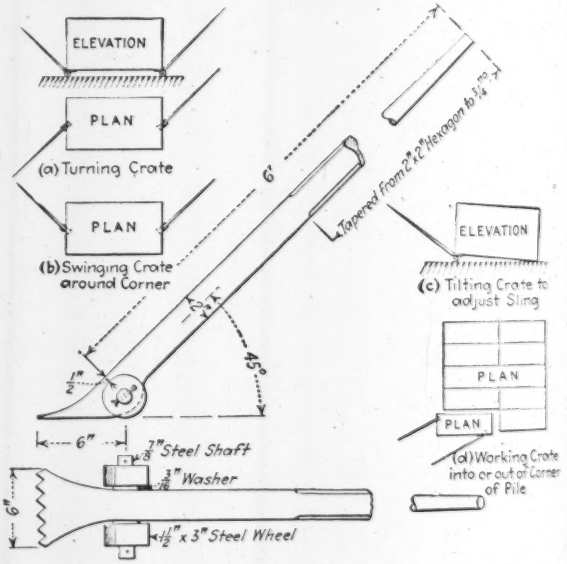
ADJOINING the whole length of the new Queenston-Chippawa power canal being built around Niagara Falls for the Ontario Hydro-electric Power Commission is a double-track standard-gage railway built to the highest standards of main-line railway construction. Necessarily, there was a considerable amount of filling to be done in laying out the road, and it was not expedient to attempt a balancing of cut and fill. In all of the low fills—that is, those up to about 8 ft.—it was found cheaper to make the fill by a caterpillar steam shovel excavating alongside the line than by using trestles from which dumps could be made or by building on grade and raising the tracks as fill was made.

The accompanying view shows one of the caterpillar tread steam shovels working alongside of the fill which it is making. Excavation is made to a few feet in depth over the area of control of the shovel, and a fill thrown up for the single-track line which is used for the fill, subsequently to be widened out to a double-track line.

CATERPILLAR STEAM SHOVEL MAKING RAILWAY FILL FROM PARALLEL CUTS

Casters Increase Utility of Pinch Bar

FOR shifting machinery, large stone blocks or other compact, heavy objects, in construction work, the pinch bar on wheels shown by the drawing will be found convenient. This has been demonstrated by its use on the Seattle, Wash., wharves of the Oregon-Washington Railway & Navigation Co. Construction of the bar is shown clearly by Fig. 1, and Figs. 1a to d indicate various methods of using it in the shifting of heavy objects.



PINCH BAR ON WHEELS FOR SHIFTING HEAVY OBJECTS

The wheels or casters serve two purposes. Besides making a vehicle of the bar, they so reduce friction between the heel of the bar and the floor that much heavier loads can be lifted than with a plain bar. The special design illustrated was worked out by S. Murray, chief engineer, Oregon-Washington Railway & Navigation Co., Portland, Ore.

NEWS OF THE WEEK

New York, December 11–December 18, 1919

A. A. E. States That It Is Not a Technical Organization

Under date of Dec. 12 the American Association of Engineers, through its national headquarters in Chicago, issued a statement containing the announcement of policy that "the association is not a technical organization but one which promotes the social and economic welfare of professional engineers."

Expect Senate To Pass Cummins Bill This Week

Leaders in the Senate early this week insisted that the Cummins railroad bill would be passed by a narrow margin before the end of the week, when the holiday recess begins, in spite of the continued debate and the failure to bring about closure up to the present writing. Late last week Senators supporting the bill began to feel considerable concern over the opposition to the measure which was developing and which was shown, by an informal poll, to be much greater than had been supposed.

Although the Railroad Administration is proceeding with its plans for returning the lines, it is now generally believed that the roads will certainly not be returned on the first of the year, in accordance with the previous announcement of policy by the President. The report of Director General Hines, which may be the basis for the President's promised message to Congress on the railroad situation, has not been made public and is still under the consideration of the President. Even should the Cummins bill be passed this week, it will not be possible to report it from conference until late in January, according to present belief in the capital. It will very probably be February or March before a final measure is passed by both houses. There is now a belief that the roads will not be returned until as late a time as June, 1920.

General Wood Joins A. A. E.

Maj. Gen. Leonard Wood, commander of the Central Department, U. S. A., has joined the American Association of Engineers. His affiliation with the organization is one result of its campaign for 10,000 new members during the first two weeks in December. His application was passed by the qualifications committee of the association on the basis of his experience, while military Governor of Mindanao, in important sanitary engineering work. He was in charge of the construction of highways, harbor improvements, railroads, schools, water-purification works and sewerage systems.

Annual Meeting of State Highway Officials

Building of Adequate Organizations and Securing of Materials Given Chief Consideration

The fifth annual meeting of the American Association of State Highway Officials was held in Louisville, Ky., Dec. 8-11, 1919, with all but six of the states represented. Chief interest centered in the problems of developing adequate organizations and of securing materials sufficient for the tremendous highway program now in hand. To maintain competent organizations, it was recognized, salaries adequate to responsibility must be paid. With reference to the supply of materials, it was recognized that there would be serious limitations of the highway program unless local supples right at the roadside, or within trucking distance, could be developed.

> ***This Week's News***
>
> *This issue carries news current for the week ending Dec. 17. It is dated Dec. 11-18, to preserve the sequence of numbers in the volume.*

The keynote of the meeting—the heavy responsibility placed upon the state highway organizations — was sounded in the presidential address of A. R. Hirst, chief engineer of the Wisconsin Highway Commission. He stressed particularly (see issue of *Engineering News-Record* of Nov. 27-Dec. 4, for address in full) the need for paying adequate salaries to both the leaders and the subordinates in highway work. The concurrence of the association in his views on compensation was indicated by the passage of a resolution recommending to the several states the consideration of a salary schedule drawn up in conference with highway officials by a committee headed by A. N. Johnson, chairman of the committee on salaries of engineers in public service, of the American Association of Engineers. This schedule was laid before the association by Mr. Johnson.

Materials

State participation in the development of supplies of road materials, even to the point of state production and state ownership of open-top cars, was discussed by A. B. Fletcher, state highway engineer of California. Unless every resource was developed, he pointed out, lack of materials would prevent the programs now planned from being completed in the periods contemplated. In discussing the subject, Watson G. Clark, highway commissioner of New Jersey, urged that the situation be squarely faced, that the conditions of materials supply in 1920 would not be materialy different from those in 1919, and that road construction programs should be planned accordingly and the public be frankly made aware of the fact. The advantage of state road-materials surveys was urged by F. E. Everett, who stated that such a survey for New Hampshire had accomplished much in solving materials-shortage problems which had previously existed. Similar surveys, it was pointed out, have been made in New York and are under way in Pennsylvania, Minnesota and several other states.

Coöperation Between States

Arthur H. Blanchard, professor of highway engineering, University of Michigan, discussed the necessity for coöperation between adjoining states for the purpose of keeping the cost of materials and construction within fair limits. Taking a group of Middle Western states, he pointed out great variations in requirements for crushed stone, paving brick, and bituminous materials. He urged that states geographically related and drawing supplies from the same sources get together and attempt to fix standards for the chief materials.

In discussion, Clifford Older, state highway engineer of Illinois, pointed out that some years ago 11 states in the northern part of the Mississippi Valley had adopted standard stone and gravel sizes. An inquiry this year regarding gravel sizes showed that 16 plants, producing 2,000,000 tons of gravel annually, were working almost entirely upon the standard aggregate agreed upon some years ago. The result of this standardization had been a cheapening of the product. Mr. Hirst, commenting further upon the coöperation of the northern Mississippi valley states, declared their efforts successful and commended to other states the consideration of Professor Blanchard's recommendations. W. G. Thompson, state highway engineer of New Jersey, called attention to a meeting held in November of this year by representatives of the highway departments of New York, New Jersey, Pennsylvania, Maryland and Delaware for the purpose of standardizing crushed stone. A standard calling for a stone that would pass a 2½-in. mesh screen and be retained on a ⅝-in. screen had been

(*Continued on page* 1032)

Engineer Work "Among Most Notable Achievements of the A. E. F.," Says General Pershing

Characterizing the large program of construction carried out by Engineer troops in the Services of Supply and elsewhere in France as "among the most notable achievements of the American Expeditionary Forces," General Pershing, in his final report, made public this week, outlines briefly some of the more important overseas projects for which the Engineers were responsible. The report is in very condensed form, considering the wide scope of the operations of the A. E. F. In so far as combatant troops are concerned, the Commander-in-Chief apparently adopted the general policy of not discussing the work of units smaller than divisions; there is, therefore, no detail regarding the performance of the divisional sapper regiments, or the corps and army engineer troops, these being included in the descriptive matter concerning the larger units of which they formed a part.

Of the construction work in the Services of Supply, however, General Pershing says:

"Among the most notable achievements of the American Expeditionary Forces was the large program of construction carried out by our Engineer troops in the Services of Supply and elsewhere. The chief projects were port facilities, including docks, railroads, warehouses, hospitals, barracks and stables. These were planned to provide ultimately for an army of 4,000,000, the construction being carried on coincident with the growth of the American Expeditionary Forces.

"The port plans contemplated 160 new berths, including the necessary facilities for discharge of cargo, approximately one-half of which were completed at the time of the armistice. Construction of new standard-gage railroad track amounted to 1002 miles, consisting mainly of cut-offs, double tracking at congested points, and yards at ports and depots. Road construction and repair continued until our troops were withdrawn from the several areas, employing at times upward of 100,000 men, and often using 90,000 tons of stone per week.

"Storage requirements necessitated large supply depots at the ports and in the intermediate and advance sections. Over 2,000,000 sq.ft. of covered storage was secured from the French, but it was necessary to construct approximately 20,000,000 sq.ft. additional. The base hospital centers at Mars and Mesves, each with 4000-bed convalescent camps, are typical of the large scale upon which hospital accommodations were provided. The hospital city at Mars, of 700 buildings, covered a ground space of 33 acres and included the usual road, water, sewerage and lighting facilities of a municipality.

"Advantages of economy and increased mobility caused the adoption of the system of billeting troops. Billeting areas were chosen near the base ports, along the line of communications, and in the advanced zone, as strategical requirements dictated. The system was not altogether satisfactory, but with the number of troops to be accommodated no other plan was practicable. Demountable barracks were used for shelter to supplement lack of billets, 16,000 barracks of this type being erected, particularly at base ports where large camps were necessary. Stables at remount stations were built for 43,000 animals. Other construction included refrigerating plants, such as the one at Gievres with a capacity of 6500 tons of meat and 500 tons of ice per day; and mechanical bakeries like that at Is-sur-Tille with a capacity of 800,000 lb. of bread per day. If the buildings constructed were consolidated, with the width of a standard barrack, they would reach from St. Nazaire across France to the Elbe River in Germany, a distance of 730 miles.

"In connection with construction work, the Engineer Corps engaged in extensive forestry operations, producing 200,000,000 ft. of lumber, 4,000,000 railroad ties, 300,000 cords of fuel wood, 35,000 pieces of piling, and large quantities of miscellaneous products."

Public Works Conference Widens Scope and Changes Name

At an executive committee meeting in New York City Dec. 5 it was decided to broaden the scope of the Engineers, Architects and Constructors' Conference on National Public Works, and to make it a general body for all business and professional men, instead of limiting it to the engineering and allied professions. The name of the conference has, therefore, been changed to the National Public Works Department Association.

Recent investigations of the association indicate that the measure for a national Department of Public Works has a much greater standing and prestige than was previously thought to exist, but it is the opinion of the association that it will take a good part of the year 1920 to put the measure through.

The expenses of the conference have been underwritten until Jan. 1, 1920, by interested persons, but from now on it will be necessary that the organization stand on its own feet. To this end a financial campaign has been initiated to raise the necessary funds, and the intention is announced of raising $100,000 to cover expenses for the ensuing year.

Stockholders of New Haven Seek Limited Receivership

Arguments on the application of a group of minority stockholders of the New York, New Haven & Hartford R.R. Co. for the appointment of a limited receiver, to press the $150,000,000 restitution suit against former directors of the company, began before Federal Judge Mack in New York City Dec. 11.

Land Valuation Case Before Supreme Court

Kansas City Southern Makes Argument for Admitting Further Evidence Before Commerce Commission

Exhaustive arguments were heard Dec. 10, before the Supreme Court of the United States, in the mandamus proceedings of the Kansas City Southern R.R., to compel the Interstate Commerce Commission to receive additional evidence in the fixing of land values and to enable the commission to ascertain and report separately the "present cost of condemnation and damages or of the purchase in excess of original cost or present value." Counsel for the railroad company contended that the commission had refused to admit evidence necessary to arrive at a true cost of reproduction, provided for in the valuation act, and attorneys for the commission asked whether that body could be required by mandamus to investigate and report the "present cost of condemnation and damages or of purchase of property used by common carrier."

Following the valuation report on the Texas Midland Ry., in which no actual values were indicated at the time, the Interstate Commerce Commission served a tentative valuation on the Kansas City Southern R.R. in November, 1916, in which it was stated that the "present value" of land was ascertained from the market value of similar adjacent lands, with allowance for peculiar adaptability for railroad use, but with nothing added for "expense of acquisition for severance damages, for engineering and for interest during construction." The carrier introduced evidence similar to that in the Texas Midland case, with respect to a portion of its land, but the commission refused to permit the introduction of evidence of the same kind covering all other land owned by the Kansas City Southern R.R. Subsequently a mandamus proceeding was brought in the Supreme Court of the District of Columbia to compel the commission to receive this additional evidence.

During the hearing Dec. 10 attorneys for the railroad pointed out that neither in the tentative valuation nor in the investigation which preceded it did the commission make any investigation or report whatever as to the "present cost of condemnation and damages or of purchase" of the railroad's land. The commission has not found, they contend, nor has it undertaken to find, the cost of reproduction of the plaintiff's right-of-way and other lands as required by the valuation act and has not complied with the explicit command of the act. Counsel for the railroad also insisted that the method used by the commission in arriving at the present value of the plaintiff's land was nothing more than the average acreage value of adjoining lands, and that this is not a fair unit to be used for purposes of valuation, since it excludes essential elements of value.

Attention also was called to the fact that the commission did not deny, in its answer to the railroad's amended petition, that the cost of acquisition of these lands by purchase or condemnation as of the valuation date, June 30, 1914, would exceed the so-called present value by the sum of $5,000,000, with a resulting aggregate cost of reproduction of approximately $10,000,000. The contention of the railroad company was that the valuation act requires the commission to ascertain and report reproduction costs, to the end that values may be before the commission for its consideration when it later proceeds to place a final value upon any railroad property.

Counsel for the Interstate Commerce Commission declared that the commission has permitted the Kansas City Southern and other carriers, including the Texas Midland, to introduce evidence in proceedings before it, the effect of which was to prove that it is impossible to comply with the requirement of the valuation act for the reason that no lawful or reasonable method upon which to rest an estimate of such a cost has been discovered, and that this had previously been demonstrated by the Supreme Court in its decision in the Minnesota rate cases.

P. J. Farrell, counsel for the Interstate Commerce Commission, presented the case for the defendant, while Samuel W. Moore concluded the argument for the plaintiff.

Chamber of Commerce Committee on Department of Public Works

The Chamber of Commerce of the United States has named a committee to consider the referendum of the National Public Works Department Association (formerly the Engineers, Architects and Constructors' Conference on National Public Works). The committee consists of Charles Nagle, William C. Redfield, R. G. Rhett, Dr. Ira N. Hollis, J. Parke Channing, L. S. Gillette, Morton C. Tuttle, Walter S. Dickey and F. A. Seiberling.

St. Lawrence Report To Appear Soon

W. J. Stewart, Dominion hydrographer, Dominion of Canada, and Col. Charles Keller, Corps of Engineers, U. S. A., who were appointed by their respective Governments to prepare a statement regarding the development of navigation resources of the St. Lawrence River, have completed their work. They have prepared, for reference to the International Joint Commission, questions covering several schemes for removing obstacles to deep-water navigation of the St. Lawrence and the development of water power which are now before the United States and Canadian Governments for consideration. Meetings will be held by the commission at various points for hearing the evidence of interested parties.

With Equipment and Men Kansas Highway Commission Aids in Coal Emergency

(From "Engineering News-Record's" Correspondent)

As an emergency method of maintaining the output of coal in Kansas, after Governor Henry J. Allen took over the mines in that state Nov. 28, road-building and excavating equipment, including steam shovels, motor trucks and tractors, were quickly mobilized and placed in service, and, through the efforts of the State Highway Commission, under M. W. Watson, chief engineer, steam-shovel operators, truck drivers and mechanics were recruited. The Governor appointed C. D. Sample and B. S. Gaitskill receivers for the operators. Headquarters were established at Pittsburg, in the heart of the main coal fields, and the Governor and the receivers operated from this point.

Steps were immediately taken to operate the mines. The first mines to be opened were the strip pits. In these the coal is close to the surface and is mined with steam shovels. All available steam shovels were borrowed from contractors and railroads and sent to the strip pits to augment the equipment already there. Counties all over the state that had trucks and tractors working on Federal-aid road construction were ordered to send them to the coal fields, with drivers if possible.

Common labor was recruited by the State Labor Commission under J. H. Crawford, commissioner of labor, from several of the larger cities, by advertising in all the Kansas papers. The various colleges in the state furnished volunteers from their student bodies, many of them sending the football teams that had just finished the season's play.

The Kansas National Guard furnished all the guards as well as the camp equipment for guards and volunteers. Mining was carried on under great difficulties, owing to the extreme cold weather, snow and sleet, but all the volunteers did good work, and the situation in Kansas was greatly relieved by this action.

A special session of the legislature of Kansas has been called to consider a special appropriation to cover the cost of this emergency. In several counties the road trucks which have not been sent to the coal fields are being used to haul wood from the timber lands to the cities. The county forces are also being pressed into service as axmen in their timber lands.

Fire Damages Upper Floors of New York Engineers' Club

Fire which broke out about 5 a.m. Dec. 12 damaged the New York Engineers' Club, at 32 W. 40th St., to the extent of about $100,000, according to the best available estimate. The fire originated on the 12th floor, where the dining rooms and kitchen are located, but was confined to the two upper floors. For a time it threatened to spread through the rear of the building to the Engineering Societies' Building, 29 W. 39th St., but was kept under control, doing only slight damage to the 13th floor of the societies building, where the engineering library is located. No damage was done to the contents of the library.

After 300 members and guests of the club were driven from their rooms to the corridors of the building, it was found that six employees who slept on the 13th floor had been unable to get down. They were brought down by two policemen who went up in an elevator through the smoke.

Future of Army's Construction Division Still Undecided

(Washington Correspondence)

The fate of the Construction Division of the Army still hangs in the balance. There is a chance that the Military Affairs Committees of Congress will recognize it as a separate corps. This is the desire of the officials of the Construction Division as well as that of a great majority of civil engineers throughout the country. It is believed that the efficiency of the Construction Division will be impaired if it is made a part of the Corps of Engineers or if it is returned to the Quartermaster Department.

The General Staff bill, which is dead as far as its general provisions are concerned, provided for the incorporation of the Construction Division in the Corps of Engineers. Nevertheless, many of the suggestions of the General Staff bill as a whole are being incorporated in the bill which will be brought out in the near future. The Dent bill, another of the rejected drafts, sends the Construction Division back to the Quartermaster General. Some of the Dent provisions are being embodied in the composite measure which is now being prepared.

In brief, the arguments against making the Construction Division a part of the Engineer Corps or a subsidiary of the Quartermaster Department are that the Engineers, with the coming of an emergency, are among the first troops to be hurried to the fighting line. Most of the duties of the Construction Division would be at training camps and other points at a distance from the scene of actual combat. Thus, it would be so far removed from its administrative organization as to make for inefficiency in time of emergency, to say nothing of the difficulties of technical developments when under the direct orders of men not schooled in its problems. To return the division to the Quartermaster Department would be a case of the tail wagging the dog, as the Construction Division is, and is certain to continue to be, a very much larger organization than the Quartermaster Corps. Even if the Army is held at 300,000 men, the amount of ad-

(Concluded on page 1034)

Annual Meeting of State Highway Officials

(*Continued from page* 1029)

adopted. Representatives of stone interests from the Buffalo district had declared that the adoption of this standard would increase their output 20 per cent.

Relations With Contractors

Relations with contractors formed the subject of three discussions. The chief one followed a paper presented by a representative of the Associated General Contractors of America on "A Better Understanding Between Contractors and Highway Officials." His recommendations were the result of a conference between members of the highway division of the Associated General Contractors. He recommended, among other things: (1) The early letting of contracts so that available car supply could be used during the winter; (2) allowing estimates for material placed on the ground before the construction season, including allowance for the cost of rehandling; (3) use of local aggregates where possible; (4) inspection of materials at the source; (5) the securing for highways of preferential treatment with reference to the use of cars; (6) the letting of jobs in long contracts, extending over more than one season, and including all the work, the surfacing, culverts, drainage, etc.; (7) consideration, in letting contracts, of the contractor's responsibility, taking cognizance of his organization, equipment, financial ability and past record; (8) safeguarding the contractor from the unnecessary risks due to calling for needless refinements, the giving out of inadequate plans, retaining a high percentage of estimates, etc. On the subject of labor his recommendation was a very simple one: Hire big, responsible contractors and let them take care of the labor problem.

He closed with the recommendation that there be appointed a joint committee of representatives of the American Association of State Highway Officials and of the Associated General Contractors of America. Such a committee was authorized by resolution of the association.

H. S. Mattimore, testing engineer of the Pennsylvania Highway Department, urged, in a paper on "Fair Relations With Contractors," care in drawing up specifications so that they will indicate exactly what is wanted; avoidance as far as possible of the clause "to the satisfaction of the engineer"; elimination of demand in the specifications for greater refinement than is actually expected; and better training of inspectors, imbuing them with a spirit of helpfulness rather than of carping criticism of the contractor. In view of the materials shortage he urged that full data be given the contractor on local materials, and, for such surveys, advised the use of engineers rather than geologists. The engineer is apt to look at the cost of getting out the materials and not merely of locating deposits.

Discussing Mr. Mattimore's paper, Paul D. Sargent, chief engineer of the Maine Highway Commission, declared that if both engineer and contractor were honest there would be no trouble. Specifications must be written rigidly in order to get from poor contractors a satisfactory quality of work. On the other hand, these rigid specifications cause the good contractor to bid on the theory that he will run into the very worst conditions. The writing of rigid specifications therefore makes the work more costly than it should be. Nevertheless, it is difficult to see how under the present circumstances the specifications can be made less rigid. He believed it more important to get fair contractors and good inspectors than to over-refine the specifications.

Contract bonds and methods of bonding companies received rather severe handling in a discussion opened by Mr. Thompson, of New Jersey, and continued by Frank F. Rogers, H. J. Kuehling, John H. Mullen, Mr. Hirst, Mr. Sargent, and others. Most of the speakers considered some form of bond desirable, but others contended that the withholding of a fair percentage of the monthly payment was sufficient protection. At present rates and with the volume of work in prospect, bond expenses will aggregate a large sum, and every effort should be made to reduce it.

State insurance, personal bonds and reduction of bond premiums were presented as means of bringing about this reduction, and their adoption was urged wherever it was possible to do so.

Relations to Federal Goverpment

A group of papers was presented on the relationship of the state highway departments with the Bureau of Public Roads. Chief of these was a paper by George P. Coleman, state highway commissioner of Virginia, in which he reported that as a result of an inquiry addressed to the states, and responded to by 33 highway departments, the conclusion was evident that the relations in general are very satisfactory. The criticisms of a few years ago have almost entirely disappeared. Improvement has been especially marked during the past year. Ninety per cent. of the projects proposed by the states have been accepted, and the delays on the other 10% are realized by the states themselves to have been entirely justified. The law itself was generally considered satisfactory. Amendment was urged so that the Federal Government would be allowed to pay more than 50% of the cost of roads built in the public-land states of the arid West. It was urged also that somewhat lower standards be permitted in the Western states, and that a competent engineer be assigned to every state highway department and receive authority to approve minor changes in plans.

In the resulting discussion, E. W. James, assistant chief engineer of the Bureau of Public Roads, gave it as the view of the bureau that it had gone as far as the law would permit in approving cheaper forms of construction. The bureau had already placed resident engineers in a number of the states and had given them the authority which Mr. Coleman suggested. Mr. James placed great stress upon the necessity, in order that payments be promptly made, of adhering strictly to the vouchering rules that had been prescribed. This system was not of the bureau's making, but had been imposed upon it by the auditors of the Department of Agriculture, through whose hands all vouchers for Federal road funds must pass. He advised that state depositories be designated for the deposit of funds in those states where county depositories are now employed. Bearing out views expressed a number of times during the meeting, Mr. James also called attention to the fact that in many states the engineering and inspection were inadequate, and that the forces were deficient both in numbers and ability.

Thomas H. MacDonald, chief of the Bureau of Public Roads, discussed the classification of highways and the proper policy of the Government with relation to the state systems. (The paper will be found in full in this issue.)

Discussing the paper, L. A. Gillette, state highway engineer of New Mexico, pointed out that even with a 4.5 mill tax levy, New Mexico could not raise enough money to meet its Federal-aid allotment. Colonel William D. Sohier, formerly of the Massachusetts State Highway Commission, pointed out, on the other hand, that a tax levy of 4 mill was sufficient in Massachusetts to meet the Federal-aid allotment. The association later adopted a resolution favoring a change in the law which will permit the Government to pay a higher proportion than 50% on the Federal-aid work in the public-land states.

Lieut. Col. H. L. Bowlby, chief of the war-materials division of the Bureau of Public Roads, explained in detail the reason for delay in delivering surplus war materials to the states, these materials being principally motor trucks. In all, 27,983 vehicles have been allotted, and of these over 9195 have already been delivered. Colonel Bowlby assured the state highway officials that each state would get its full allotment of trucks and of Ford cars, but stated that there was some uncertainty whether they would get the full allotment of touring cars. He also said that there was likelihood of each state obtaining 100% additional in Ford cars, probably with ambulance bodies.

He explained in detail the Kahn bill now in Congress (passed by the Senate but pending in the House), which would make it mandatory upon the Secretary of War to turn over to the states surplus material that could be used for highway building, including not merely trucks, but mixers, rollers, pumps, hoisting engines, etc. He pointed out that the bureau had recommended an amendment to the bill which would transfer to the states, in addition, gaso-

line engines, movable mess equipments, mobile machine shops and equipment for motor-truck repair shops. At the close of the meeting the convention passed a resolution urging upon Congress the passage of the Kahn bill with the amendment suggested by the bureau.

Rollen J. Windrow, state highway engineer of Texas, presented a paper on the use of the Federal equipment by the state after its receipt. In some states the equipment is rented to the contractors and in other cases used on force-account work.

MISCELLANEOUS SUBJECTS

Discussing design of pavement, Charles M. Upham, state highway engineer of Delaware, said that in the laying out of commercial routes the straightest practicable line should be chosen between the points served. Grades should be reduced as far as possible. Widths are dependent on density of traffic. The tendency in determining widths should be liberal rather than sparing. There is a point beyond which the width of a single slab is objectionable, and at this point it would be wise to consider whether a separate track should not be prepared for heavy, slow traffic and for light, high-speed traffic. In the matter of thickness of surface the thought of designers should be toward reduction of slab depth, and to make this possible sub-base construction should be improved and increased stability secured by better drainage.

On the matter of surveys, Capt. P. St. J. Wilson, chief engineer, Bureau of Public Roads, stated that the majority of the states seemed to be satisfied with the methods laid down by the bureau. In the discussion there was unanimity in the view that plans could not be made too complete. Completeness of plans always brought returns in lower bids. Quantities should be double-checked, and whatever sums spent that were necessary to make the plans complete.

On the subject of taxation, S. E. Bradt, superintendent of highways of Illinois, maintained that the direct benefits of improved roads to the road users, in reduced cost of fuel, tires, upkeep, etc., were far in excess of the present license fees. In Illinois the average fee for 1917 was $5 a car; for 1918, $7, and in 1920 would be about $10. The fees for 1920 should produce about $5,000,000, of which $2,000,000 will be used for maintenance and the rest will go into the general highway fund. Whereas the automobile license fees will yield about $5,000,000 in 1920, $15,000,000 will be contributed out of the tax levy. For this $15,000,000 the public receives the indirect benefits due to reduction in the cost of food, better rural schools, increase in property values, etc. The ratio of 1 to 3, in Mr. Bradt's opinion, is not correct, as the automobile and motor-truck users receive, in proportion, a larger benefit. Therefore the license fees should be raised. The motorists, he maintains, will agree to this, as was shown by the fact that they voted the Illinois $60,000,000 bond issue, which is to be entirely carried and amortized from automobile and motor-truck license fees. He said that at present there was one car to every 12 persons in the State of Illinois and that by 1923, it was expected, there would be one car for every eight persons.

He maintained that the horsepower rating was not equitable, since one man might use his car to a much greater extent than another. He suggested the possibility of a gasoline tax, which would be in proportion to the use of the vehicle.

Discussion of Mr. Bradt's paper brought out the fact that in three states, Colorado, New Mexico, and Oregon, there are gasoline taxes; 1c. a gallon in Colorado and Oregon and 2c. a gallon in New Mexico. The New Mexico law has been attacked on the basis of its constitutionality (as class legislation) and the case is now before the United States Supreme Court.

George H. Biles, assistant highway commissioner of Pennsylvania, read an exhaustive paper on the organization of a highway department, going into the executive, construction, maintenance, township, auto registration and accounting divisions.

In addition to the resolutions heretofore noted, resolutions were adopted urging that the United States Government become a member of the permanent International Road Congresses and that the association support the movement to have the International Congress brought here in May, 1920. Honorary membership was abolished. The support of the national Government and the states for the completion of the topographic mapping of the United States by the year 1932 was strongly urged. Indorsement was given to the present laws governing expenditure of Federal aid through the existing agencies. Coupled with the last resolution was the recommendation that sums of $100,000,000 a year be made available for each of the fiscal years ending June 30, from 1921 to 1924, inclusive. It was urged in the resolution relating to Federal aid that a national highway system be developed, but under the Federal-aid plan.

Officers for the ensuing year were elected as follows: President, Paul D. Sargent; vice-president, W. S. Keller; secretary, Col. Joseph Hyde Pratt; treasurer, John H. Mullen; new members of executive committee: Thomas H. MacDonald (reëlected), George E. Johnson (reëlected), A. B. Fletcher, S. E. Bradt and W. R. Neel. The holdover members of the executive committee are George P. Coleman, W. G. Thompson, Lieut. Col. W. D. Uhler, Ira H. Browning and Charles J. Bennett.

Iowa Engineers Must Register

Unless engineers desiring to practice in Iowa register before July 4, 1920, they will be guilty of a punishable offense should they continue to practice. All professional engineers and land surveyors are included in the provisions of the law which requires registration upon their professional requirements without examination up to Jan. 4, 1920. Thereafter, until July 4, 1920, technical examination before the Board of Examiners is required. After the latter date the law is in full force. The penalty is a fine of not less than $100 or more than $500. K. C. Kastberg, Des Moines, is secretary of the Board of Examining Engineers. Other members are Seth Dean, L. M. Martin, F. W. Stubbs and Alvin Le Van.

Ask Appropriation for Delaware River Bridge

An initial appropriation of $1,000,000 for beginning the construction of a bridge across the Delaware River to connect Philadelphia and Camden is asked of the New Jersey legislature by the state's members of the Interstate Bridge and Tunnel Commission. The same body requests a further appropriation of the same amount for the Hudson River highway tunnel between New York and Jersey City, to which project the state, in conjunction with New York State, is already committed by an appropriation made early in 1919.

St. Louis Municipal Engineers Receive Pay Increase

An ordinance providing for increased compensation for professional engineers employed by the City of St. Louis has been passed by the Board of Aldermen of that city. The ordinance was prepared last spring by the municipal section of the St. Louis Chapter of the American Association of Engineers.

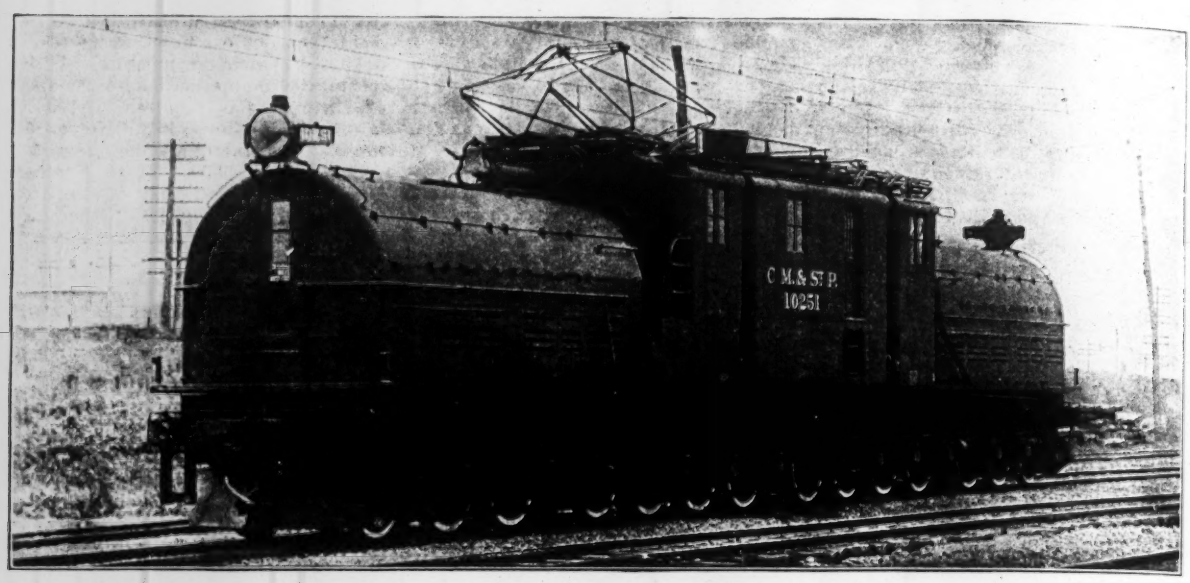
Newark Zoning Ordinance

A zoning ordinance, providing for the regulation of building in Newark, N. J., specifying building heights and uses, and localizing types of construction, passed its second reading before the Newark City Council Dec. 4. Because of certain minor changes proposed, the ordinance was returned to the second reading Dec. 11. Hearings are now being held and final action will be taken when the council meets Dec. 24. Applications for permits to build under the provisions of the new ordinance, aggregating $9,000,000, have been received.

San Diego & Arizona Ry. Open

The new San Diego & Arizona Ry., from San Diego, Calif., to El Centro, in the Imperial Valley, was formally opened to local and transcontinental passenger traffic Dec. 1, with ceremonies under the auspices of the railroad company and the San Diego Chamber of Commerce. On Dec. 10 through pullman service was established on the Golden State Limited, between San Diego & Chicago. A description of the route covered by the railroad appeared in *Engineering News-Record* of Aug. 22, 1918, p. 365.

Gearless Electric Locomotive Develops 115,000-Pound Tractive Effort



New electric locomotives weighing 265 tons, capable of a maximum starting tractive effort of 115,000 lb., are being placed in service on the Othello-Seattle-Tacoma Cascade electric zone of the Chicago, Milwaukee & St. Paul Ry. They are built for passenger service and are of the bipolar gearless type, with motor armatures mounted directly on the driving axles with 12 motors. The locomotives are designed for handling, in normal service, a 12-car train weighing 950 tons against a grade of 2% at 25 miles per hour, which requires 56,500-lb. tractive effort. They were built by the General Electric Company.

Future of Army's Construction Division Still Undecided

(*Concluded from page* 1031)

ditional construction for its housing is a tremendous proposition. Under peace-time conditions, it is admitted, the Army will not be content to be housed in temporary shacks. The new Army program, even if held below the desires of the General Staff, is certain to call for very much construction.

At present, while the matter is being thrashed out, most of the Construction Division projects are being held up. A large amount of work, however, is being required to maintain the temporary housing of the Army. Three ammunition-storage warehouses are in course of erection. These plants call for an expenditure of $15,000,000. They are located at Salt Lake City, Savannah, Ill., and Sparta, Wis.

Philadelphia Proposes New Loan Bill

A bill providing for the floating of a loan to raise funds with which to construct civic improvements in Philadelphia has been declared unconstitutional, owing to a provision in the new charter which makes it unlawful to pay for repair work with funds raised otherwise than by direct taxation. Capital outlay, or new construction work, alone, may be paid for with money raised by a loan bill.

A new bill has, therefore, been framed for the floating of a $62,100,000 loan providing for new work that must be done, and not including repairs and maintenance which must come out of the financial budget.

Some road work had already been done by the city before the former bill was declared unconstitutional, and it has become necessary for the city to raise $78,000 for the Barber Asphalt Paving Co. and $87,000 for the Union Paving Co., to pay for completed work. The question still arises whether the contracts awarded under the old bill will be held valid, or whether new bids will have to be advertised and new contracts awarded on over $2,000,000 worth of work on bridges, sewers and general road repairs.

City Planning at Philadelphia

Through the coöperation of the engineers and architects of Philadelphia, led by the Engineers' Club, the Philadelphia Planning Conference has been organized to unite the art, technical and civic organizations of Philadelphia in the promotion of city planning and zoning. An exective committee of a dozen men from various organizations has been created, with D. Knickerbocker Boyd, Philadelphia Chapter, American Institute of Architects, as chairman, A. W. Crawford, of the Art Society and City Park Association, as secretary, and J. A. Steinmetz, president of the Engineers' Club, as the ex officio member. The conference will urge a budget providing for a zoning and planning commission.

Work Commenced on Port of Birmingham

Contracts aggregating $100,000 have been let for the construction of terminals on the Warrior River, 18 miles from Birmingham, Ala. These terminals will form the basis of a port for that city. The work at present is under the direction of a private company, known as the Port of Birmingham Co., which has made public sale of stock to the amount of about $200,000, and hopes eventually to have the port taken over by the municipal or state Government.

The port is located on the Warrior River, just below the Ensley Southern Ry. crossing. It is connected to the City of Birmingham by that railroad. The plans at present comprise a grading of the steep bank of the river, the continuation of the track from sidings to benches about 40 ft. above high water in the river, and the provision of trains running on these tracks to unload the barges which can be moored to the foot of the bluff. It is also intended to install unloading trestles for downstream-bound coal or slag, etc., from Birmingham. In the first construction will be included labor quarters. The Warrior River has been improved by the Government, contains locks and dams, and provides 8-ft. minimum depth to Mobile, 419 miles below the terminal. The river is now being operated by the inland waterway section of the United States Railroad Administration. C. F. Wood, Birmingham, Ala., is chief engineer of the Port of Birmingham Company.

Civil Service Examinations

Canada. Instructor in mathematics, Royal Military College, Kingston, Ont., $1800 per year. File application with Civil Service Commission of Canada at Ottawa, Ont., before Dec. 26.

United States

For United States civil service examinations, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Town manager, $2400 per year, Dec. 16. To fill vacancy in Ordnance Department, Nitrate Plant No. 1, Muscle Shoals, Ala. File applications before Dec. 16.

Structural steel inspector, Naval Ordnance Plant, South Charleston, W. Va., $7.04 per diem, Dec. 23. File applications before Dec. 23.

Architectural and structural steel draftsman, Lighthouse Service, Key West, Fla., $1560 per year, Jan. 6. File application before Jan. 6.

Fire-prevention engineer, office of Director of Purchase and Storage, War Department, duty throughout United States, $2500 to $4000 per year, Jan. 13. Application should be filed before that date.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

BRIDGE BUILDERS' & STRUCTURAL SOCIETY, 50 Church St., New York City; Jan. 16, New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS, 29 W. 39th St., New York City; Jan. 21-22, New York City.

ENGINEERING INSTITUTE OF CANADA; General Secretary, Fraser S. Keith, 176 Mansfield St., Montreal; Jan. 27-29, Montreal.

AMERICAN ROAD BUILDERS' ASSOCIATION, 150 Nassau St., New York City; Feb. 9-13, Louisville, Ky.

AMERICAN WOOD-PRESERVERS' ASSOCIATION; Secretary-Treasurer, F. J. Angier, Mt. Royal Station, Baltimore; Feb. 10-12, Chicago.

AMERICAN CONCRETE PIPE ASSOCIATION; 210 South La Salle St., Chicago; Feb. 20-21, Chicago.

The **Arkansas Association of Surveyors, Civil Engineers and Architects** will hold its 11th annual meeting at the Hotel Marion, Little Rock, Dec. 30-31, 1919. One of the principal subjects to be dealt with will be **"After-War Problems With Which the Profession Is Now Confronted."**

The **Montreal Branch of The Engineering Institute of Canada,** Dec. 11, was addressed by **John Grieve** on "Paint for Protection of Steel Work," and by John T. Farmer on "Mechanical Stokers." Mr. Farmer spoke in behalf of the Combustion Engineering Corporation.

The San Francisco Chapter of the American Association of Engineers at the annual meeting Dec. 4 elected the following officers: President, William S. Wollner; vice-president, J. F. Johnston; treasurer, L. R. Kessing; secretary, A. G. Mott.

The Los Angeles Chapter of the American Association of Engineers held a get-together meeting Dec. 9 for the purpose of formally amalgamating the Engineers and Architects' Association of Southern California and the Los Angeles Chapter of the American Association of Engineers. The program included a declaration of the amalgamation by President H. Z. Osborne, Jr., and talks on "The Engineer and His Relations to the Public" by F. H. Olmsted, and "The American Association of Engineers," by Samuel Starrow. The joint organization has opened headquarters at 625 Metropolitan Bldg., Los Angeles, and during the week of Dec. 8-13 meetings were scheduled for every evening, to forward a membership drive for raising the membership from 450 to 1000.

The Illinois Section of the American Water Works Association met Dec. 10 in Chicago and heard papers by Dr. Edward Bartow, formerly lieutenant colonel in charge of water laboratories in France, on "Water-Supply Service of the A. E. F.," and L. A. Fritze, formerly captain, on "Water Service of the Forty-Second Division," for which he was water-supply officer. It is Captain Fritze's observation that chaos exists for the first three days of any battle, and that the size of the present canteen should be enlarged to hold a two-day supply. He recommended that a place in the army organization be provided for water-supply men, including sanitary engineers, chemists and bacteriologists. The section indorsed the idea, by resolution.

The San Francisco Engineers' Club Dec. 4 was addressed by M. M. O'Shaughnessy, city engineer of San Francisco, on the Hetch Hetchy power project. Motion pictures were used to illustrate the address.

PERSONAL NOTES

GEORGE F. SPROULE has been appointed director of the Department of Wharves, Docks and Ferries of the City of Philadelphia by Mayor-elect Moore. Mr. Sproule entered the Board of Port Wardens in 1884, and four years later was elected secretary of the board and held this position continuously until the abolishment of that body in 1907, when he was appointed to the position of secretary of the Commissioners of Navigation.

D. Q. MCCOMB, previously major, Engineers, U. S. A., has been appointed engineer in the United States Public Roads Bureau and assigned to duty at Birmingham, Ala., where he will have charge of Federal-aid road projects now under construction in Jefferson County, as well as some Federal-aid road work in the State of Tennessee. Before entering the Army Mr. McComb was connected with the Pittsburgh Testing Laboratories.

H. W. HOLMES, previously associated with the Oregon State Highway Commission, and more recently with the engineering department of the City of Portland, Ore., has been appointed bridge engineer, Montana State Highway Commission, with headquarters at Helena, succeeding F. E. PHILLIPS, resigned.

COL. C. LINCOLN FURBUSH has been appointed director of public health, City of Philadelphia, by Mayor-elect Moore.

H. J. DOOLITTLE, highway engineer in charge of state and Federal highway construction in eastern Washington, has been chosen by the Board of Commissioners of Spokane County, Washington, as special construction engineer on permanent highways to be constructed under the $3,250,000 county bond issue.

CAPT. M. J. MCMAHON, Air Service, U. S. A., recently discharged from the service, is now general superintendent for Aronburg & McDonald, general contractors, Newcastle, Penn.

L. L. PIERSALL, of the Kentucky State Road Department, has been appointed chief engineer in charge of the construction of the Ohio River Federal-aid road from Louisville to Paducah. Prior to becoming a state employee, Mr. Piersall was a road engineer with the Louisville & Nashville Railroad Company.

CAPT. ALBERT SPENGLER, Quartermaster Corps, U. S. A., who served a year in the construction division as assistant to the constructing quartermaster, Brooklyn Army Supply Base, and as constructing quartermaster of the Baltimore depot, was recently discharged from the service, and has returned to the Pauly Jail Building Co. as engineer and superintendent of construction.

COL. T. H. DILLON, Corps of Engineers, U. S. A., has resigned from the Army to accept appointment as professor of electrical engineering at the Massachusetts Institute of Technology. In his new position Colonel Dillon will be concerned chiefly with electric-railway problems, including tramways, the electrification of steam railroads, and problems of power transmission. His service included a period on the Panama Canal as superintendent of the Gatun locks. He was also in charge of engineering in the locks division and the hydrographic division. In 1918 he went to France as colonel

in command of the 37th Engineers, a special electrical-mechanical regiment, later becoming deputy chief engineer of the First Army, A. E. F., during the St. Mihiel, the Aisne-Marne and the Argonne-Meuse campaigns. After the armistice Colonel Dillon was attached to a board for the valuation of damages in allied countries, of which board Brig. Gen. C. H. McKinstry was chief.

F. L. METZGER, formerly vice-president, Electric Welding Co., Pittsburgh, and JOSEPH G. RICHARDSON, captain, Chemical War Service, in charge of designing at Edgewood Arsenal, have organized the METZGER-RICHARDSON Co., with offices at 331 Fourth Avenue, Pittsburgh, to engage in consulting engineering, specializing in reinforced-concrete designing and furnishing and fabricating steel for concrete and other building specialties.

ROBERT C. WALKER, architectural engineer, Washington, D. C., has opened a branch office at Salisbury, Md.

HAROLD L. HOCK, formerly a lieutenant of Engineers, has returned to the New York State Highway Department, with headquarters in Buffalo. While overseas Lieutenant Hock was decorated with the Croix de Guerre.

C. A. FERGUSON, formerly of Richester, N. Y., who, as captain in the Corps of Engineers, was supervising engineer of the Raritan, N. J., arsenal, has established himself in business in Seattle, Wash., under the firm designation of the FERGUSON CONSTRUCTION COMPANY.

JOHN W. FOTHERGILL, recently returned from overseas with the 309th Engineers, has become connected with the MORGAN ENGINEERING Co., Memphis, Tenn.

JULIUS ADLER, for the past seven years with the Pennsylvania State Highway Department, the last three of which have been spent as engineer of tests, has resigned and has accepted the position of technical engineer in the asphalt department of the Atlantic Refining Co., Philadelphia.

LOGAN MCDONALD, Lothair, Mont., has been elected county surveyor of Liberty County, Montana, with headquarters at Chester.

E. L. GRANT, assistant district engineer, United States Geological Survey, has resigned to become a member of the faculty of Montana College of Agriculture and Mechanic Arts at Bozeman. Mr. Grant has been located at Topeka, Kan., since last April.

OBITUARY

SIR JOHN JACKSON, civil engineer and contractor for public works in various parts of the world, died in London, Dec. 15, at the age of 68. He was educated in the University of Edinburgh, receiving the training of a civil engineer. He was the contractor for the last section of the Manchester Ship Canal, and for the foundations for the Tower Bridge and Dover harbor work. In recent years he completed the Admiralty dock at Keyham, Devonport, as well as Admiralty harbor work in South Africa and India. He carried out the contract for the construction of the railway across the Andes Mountains from Arica, on the Pacific Coast, to La Paz, the capital of Bolivia. More recently he was engaged in irrigation works in Mesopotamia and harbor works in Canada. He was knighted in 1895.

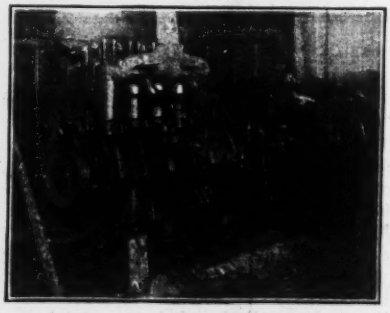
CHARLES E. LOGUE, of the Logue Building Co., Boston, was killed recently, when he fell from a ladder upon which he was descending after the general inspection of a church building in Bridgeport, Conn. Mr. Logue had erected several important buildings in Bridgeport, and was the contractor for the Fenway Park baseball grounds of the Boston American League team.

CORNELIUS KENNEDY, street-paving contractor, Parkersburg, W. Va., died in that city Dec. 7. Mr. Kennedy entered the paving business in the early 80's and took an active part in construction work until a few months ago, as senior member of the firm of C. Kennedy & Son, street and road builders, Parkersburg, which has been succeeded by the Kennedy Construction Co., of which his son, John R. Kennedy, is president and general manager.

Tractor Engine Operates Plant During Coal Crisis

Before the coal strike was settled, the fuel situation in Peoria, Ill., became so serious that power was denied all manufacturing plants, which meant a complete shutdown for most of the institutions. As soon as notice was received that power would be cut off, engineers of the Holt Manufacturing Co., makers of caterpillar tractors, arranged to run the busiest parts of the plant by connecting block test dynamos with two 55-hp. tractor engines to supply direct current for the large traveling cranes and hoists. In addition, several 55-hp. engines were placed on stands throughout the shop and belted up directly to line-shaft pulleys, and two 5-ton tractors were brought in, and their power pulleys connected with line shafting serving two more divisions of the plant.

A considerable portion of the plant operated in this manner up to the time of the raising of fuel restrictions, while a 120-hp. motor was connected with a power house generator to furnish lighting current.



TRACTION ENGINE SUPPLIES EMERGENCY POWER TO MANUFACTURING PLANT

BUSINESS NOTES

JENKINS BROS., manufacturers of valves, New York City, will in the near future increase their manufacturing facilities by acquiring a new plant in Bridgeport, Conn.

CHARLES R. POLLARD has resigned as sales manager, Alexander Milburn Co., Baltimore, Md., and has joined the sales organization of the Dravo Doyle Co., merchant engineers, Pittsburgh.

The CLINTON WATER & WATER SUPPLY CO., Clinton, N. J., has under advisement an extension of about four miles of pipe line during the year 1920. Since the death of W. B. Meetch, president of the company, all of the interests have been purchased by E. E. Tomson and Chester Tomson, the latter continuing as secretary under the new management.

JOHN J. MOORE, JR., has joined the sales force of the Beaver Board Co., with offices at 225 Fifth Ave., New York City.

TRADE PUBLICATIONS

The following companies have issued trade publications:

JULIEN P. FRIEZ & SONS, Belfort Meteorological Observatory, Baltimore; catalog B, 6 x 9 in., 58 pages, illustrated, including information on standard meteorological instruments and apparatus, and Circular W (third edition) 6 x 9 in., 24 pages, illustrated, describing improved automatic water-stage registers.

THE OWEN BUCKET CO., Cleveland; folder, 6 x 9 in., illustrated, describing "Owen Type L" buckets.

WALLACE & TIERNAN CO., INC., New York City; folders, 7½ x 8 in., illustrated, on "Safe Transport" of tubed media for bacterial analysis of water and sewage; and "An Automatic Discharge Counter" developed to record the application of sewage from dosing chambers to sprinkling filters or contact beds.

STERLING ENGINE CO., Buffalo; catalog, 8½ x 11 in., 24 pages, illustrated, describing various types and uses of "Sterling" internal combustion engines particularly designed for adaptability to use in auxiliary power plants.